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REPORTS

TO THE

LOCAL GOVERNMENT BOARD

ON

PUBLIC HEALTH AND MEDICAL SUBJECTS.

(NEW SERIES No. 109.)

STATISTICS

OF THE

INCIDENCE OF

NOTIFIABLE INFECTIOUS DISEASES

IN EACH SANITARY DISTRICT IN ENGLAND AND WALES DURING THE YEAR 1915 (FIFTH YEAR).

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STATISTICS

OF THE

Incidence of Notifiable Infectious Diseases in each Sanitary District in England and Wales during the year 1915.

To the Right Honourable Walter Hume Long, M.P.,
President of the Local Government Board.

Sir,

I have the honour to submit the following statistics of cases of notifiable infectious diseases reported during the year 1915. The statement comprises the number of cases and the incidence in relation to population of each of the notifiable acute infectious diseases in every sanitary area of England and Wales and in certain grouped areas. This statement is the fifth complete annual record of the kind. The series of statistics of infectious diseases to which it belongs was rendered practicable by the Board's General Order of 13th December, 1910, which made it the duty of Medical Officers of Health of extra-metropolitan sanitary areas to transmit to the Board each Monday a statement of the number of cases of infectious disease notified to them during the preceding week. A weekly summary of these returns, giving the cases notified in every sanitary area, is sent out by the Board on the Thursday of the week following that to which the summary relates, to every medical officer of health. The statement of the number of cases of infectious diseases notified during the year 1915 in each district in England and Wales, which is given in the following pages, is based on these weekly returns.*

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* Similar information is given for the Metropolis, returns for which are sent to the Board weekly by the Metropolitan Asylum Managers. These returns are compiled from copies of notifications received by the Managers from Metropolitan Medical Officers of Health under Sec. 55 (4) of the Public Health (London) Act, 1891. The weekly returns from ports are made in pursuance of the duty imposed on the Port Medical Officers of Health, except in the case of London, by the Board's General Order. The returns for pulmonary tuberculosis in London are derived from information supplied by Dr. Hamer.

(7630—29.) Wt. 58429—715. 2250. 3/16. D & S. G. 20/ 40.

Description of the Tables.—The statistics are tabulated in order of counties given alphabetically.

The statistics for administrative counties as a whole are shown in the summary table on pp. 12-15, and for county boroughs on pp. 16-17.

The statistics for each county contain information as to the incidence of the chief acute infectious diseases in—

1. The entire administrative county.
2. Each county borough within the geographical county.
3. The aggregate of the boroughs and urban districts situate within the administrative county.
4. The aggregate of the rural districts situate within the administrative county.
5. Each single borough and urban district.
6. Each single rural district.

In each of the tables the number of cases and the rate per 1,000 of population are given for each of the following diseases:—

Small-pox.
Scarlet Fever.
Diphtheria.
Enteric Fever.
Puerperal Fever.
Erysipelas.

Cases of typhus fever are shown in footnotes to the county tables.

No cases of cholera or plague occurred during 1915.

As already stated, case-rates are given for each sanitary area in England and Wales. Many of these districts have very small populations, and in many instances the rate is calculated on one or only a few cases of disease. In this respect the practice of the Registrar-General has been followed. **Although for convenience of reference such rates have been given, it is evident that in judging of their significance reference should always be made to the population and to the number of cases of sickness on which each rate is based.**

It is unnecessary to labour the point that the epidemiological and administrative value of the rates set out in the tables in this return steadily increases as it becomes possible to compare a longer series of years.

Cases of Sickness among Sailors and Soldiers.—As is well known, the duty of notifying cases of infectious diseases to the Medical Officer of Health does not apply in respect of persons living in any building, &c., belonging to H.M. the King; and

the statistics given in the four previous annual returns do not include military or naval cases of these diseases. In connection with the further increase in the naval and military population during 1915 and with the concentration of troops in special localities, many notifications of military and naval cases have been sent to Medical Officers of Health; but in view of the irregular extent to which this has occurred, and of the disturbing effect on local statistics, it has been decided not to include these notifications in the returns for each sanitary area. They are stated separately in Table I. for England and Wales as a whole.

Sickness Statistics for 1915.—During 1915, the total number of cases of the chief notifiable diseases in England and Wales, including cases in ports but excluding cases among sailors and soldiers, was as follows:—

Disease.	England and Wales, 1915.	
	No. of cases notified.	Rate per 1,000 of population.
Tuberculosis, (pulmonary)	73,358	2·07
„ (other forms)	22,864	0·65
Small-pox	90	0·00
Typhus Fever	45	0·00
Scarlet Fever	127,086	3·59
Diphtheria	53,597	1·52
Enteric Fever	6,364	0·18
Continued Fever	63	0·00
Relapsing Fever	—	—
Puerperal Fever	2,057	0·06
Erysipelas	23,382	0·66
Cerebro-Spinal Fever...	2,566	0·07
Poliomyelitis	517	0·01
Cholera...	—	—
Plague	—	—
Ophthalmia Neonatorum	6,806	8·34*

* Rate per 1,000 births.

Of the above, the following cases, being chiefly cases of imported disease, were notified to port sanitary authorities:—

Small-pox, 12; Typhus Fever, 1; Scarlet Fever, 65; Diphtheria, 48; Enteric Fever, 161; Erysipelas, 36; Continued Fever, 6; Pulmonary Tuberculosis, 784; Tuberculosis (other forms), 47; Cerebro-Spinal Fever, 8; Ophthalmia Neonatorum, 4.

Seasonal Incidence.—The following table shows the seasonal incidence of scarlet fever, diphtheria, enteric fever, cerebro-spinal fever, and poliomyelitis during 1915. The actual average weekly number of cases is given at the base of each column. The proportion of the notifications to this average taken as 100 is shown for each week, any special seasonal excess of 30 per cent. over the mean for the whole year being shown by black type.

England and Wales.

Week ending (1915).	Scarlet Fever.	Diph-theria.	Enteric Fever.	Cerebro-Spinal Fever.	Polio-myelitis.
Jan. 9	117	111	120	22	50
" 16	115	110	129	45	30
" 23	110	111	102	31	30
" 30	113	107	104	51	60
Feb. 6	112	113	102	100	50
" 13	105	119	100	106	80
" 20	104	103	103	**169**	50
" 27	103	95	93	**220**	50
March 6	96	104	91	**241**	40
" 13	97	91	89	**273**	70
" 20	96	100	99	**247**	20
" 27	94	95	87	**282**	110
April 3	82	84	85	**226**	60
" 10	86	79	105	**265**	60
" 17	89	81	129	**333**	40
" 24	87	86	88	**239**	50
May 1	95	87	101	**233**	**130**
" 8	96	90	116	**200**	40
" 15	88	80	76	**171**	20
" 22	87	72	98	**155**	90
" 29	75	73	79	122	30
June 5	86	70	74	114	60
" 12	93	83	93	100	50
" 19	90	85	91	78	10
" 26	91	82	88	78	90
July 3	99	86	103	75	30
" 10	93	93	107	102	40
" 17	91	90	84	69	20
" 24	95	85	107	67	50
" 31	87	81	107	47	110
Aug. 7	83	73	84	33	20
" 14	83	79	97	35	90
" 21	75	74	87	31	**160**
" 28	81	85	89	35	70
Sept. 4	87	95	106	33	**260**
" 11	101	97	105	47	**220**
" 18	109	114	**143**	45	**300**
" 25	109	122	**151**	35	**270**
Oct. 2	113	113	111	16	**250**
" 9	**131**	121	**143**	39	**240**
" 16	**140**	**134**	**132**	29	**350**
" 23	**132**	**137**	**130**	31	**260**
" 30	126	**139**	106	31	**200**
Nov. 6	124	**133**	107	35	80
" 13	121	**130**	116	49	**200**
" 20	115	118	84	24	**140**
" 27	113	119	93	37	80
Dec. 4	109	119	104	49	70
" 11	104	126	62	43	70
" 18	100	119	70	27	90
" 25	81	100	75	37	30
Jan. 1	90	108	75	41	100
	100	100	100	100	100
Average weekly number of cases notified.	2,444	1,031	122	49	10

Sickness Rates per 1,000 of Population.

Disease.	Year.	England and Wales (including Ports).	England.	Wales (including Monmouth).	London.	Aggregate of Administrative Counties of— England (excluding London).	Aggregate of Administrative Counties of— Wales (including Monmouth).	Aggregate of County Boroughs of— England.	Aggregate of County Boroughs of— Wales (including Monmouth).	Aggregate of Non-County Boroughs and Urban Districts of— England (excluding London).	Aggregate of Non-County Boroughs and Urban Districts of— Wales (including Monmouth).	Aggregate of Rural Districts of— England.	Aggregate of Rural Districts of— Wales (including Monmouth).
Small-pox	1911	0·01	0·01	0·00	0·02	0·01	0·00	0·01	—	0·01	0·00	0·00	0·00
	1912	0·00	0·00	0·00	0·00	0·00	0·00	0·01	—	0·00	—	0·00	0·00
	1913	0·00	0·00	0·00	0·00	0·00	—	0·00	0·02	0·00	—	0·00	—
	1914	0·00	0·00	0·00	0·00	0·00	—	0·00	0·01	0·00	—	0·00	—
	1915	0·00	0·00	—	0·00	0·00	—	0·00	—	0·00	—	—	—
Scarlet Fever	1911	2·90	2·84	3·66	2·33	2·71	3·62	3·32	3·85	2·91	4·43	2·37	2·49
	1912	2·98	2·95	3·35	2·51	2·77	3·32	3·46	3·46	2·95	3·88	2·47	2·52
	1913	3·58	3·51	4·52	3·89	2·96	4·40	4·26	5·05	3·18	5·23	2·61	3·20
	1914	4·47	4·38	5·40	5·54	3·87	5·28	4·74	5·90	4·12	6·07	3·45	4·13
	1915	3·59	3·53	4·39	3·94	3·32	4·66	3·71	3·17	3·43	5·36	3·14	3·66
Diphtheria	1911	1·33	1·33	1·30	1·64	1·22	1·21	1·47	1·68	1·22	1·11	1·09	1·36
	1912	1·24	1·24	1·27	1·57	1·10	1·13	1·32	1·84	1·17	1·13	1·00	1·13
	1913	1·39	1·39	1·40	1·70	1·26	1·30	1·48	1·86	1·41	1·39	1·03	1·16
	1914	1·61	1·60	1·53	2·02	1·53	1·42	1·54	2·02	1·66	1·54	1·32	1·24
	1915	1·52	1·52	1·43	2·11	1·40	1·38	1·49	1·64	1·49	1·43	1·25	1·30
Enteric Fever	1911	0·38	0·38	0·38	0·23	0·39	0·40	0·43	0·26	0·43	0·52	0·33	0·24
	1912	0·23	0·23	0·21	0·16	0·22	0·20	0·28	0·25	0·24	0·24	0·18	0·14
	1913	0·23	0·22	0·23	0·17	0·22	0·24	0·25	0·18	0·24	0·28	0·18	0·17
	1914	0·24	0·23	0·17	0·17	0·23	0·17	0·24	0·13	0·25	0·20	0·20	0·13
	1915	0·18	0·18	0·15	0·14	0·17	0·16	0·20	0·10	0·19	0·19	0·14	0·11

Sickness Rates per 1,000 of Population—cont.

Disease.	Year.	England and Wales (including Ports).	England.	Wales (including Monmouth).	London.	Aggregate of Administrative Counties of— England (excluding London).	Aggregate of Administrative Counties of— Wales (including Monmouth).	Aggregate of County Boroughs of— England.	Aggregate of County Boroughs of— Wales (including Monmouth).	Aggregate of Non-County Boroughs and Urban Districts of— England (excluding London).	Aggregate of Non-County Boroughs and Urban Districts of— Wales (including Monmouth).	Aggregate of Rural Districts of— England.	Aggregate of Rural Districts of— Wales (including Monmouth).
Puerperal Fever	1911	0·06	0·06	0·06	0·07	0·04	0·06	0·08	0·04	0·05	0·07	0·03	0·05
	1912	0·06	0·06	0·07	0·08	0·05	0·07	0·07	0·06	0·05	0·09	0·04	0·04
	1913	0·05	0·05	0·05	0·08	0·04	0·05	0·07	0·05	0·04	0·05	0·03	0·04
	1914	0·06	0·06	0·07	0·09	0·05	0·07	0·08	0·07	0·05	0·08	0·04	0·06
	1915	0·06	0·06	0·07	0·06	0·04	0·07	0·08	0·07	0·05	0·08	0·04	0·06
Erysipelas	1911	0·69	0·71	0·44	1·09	0·56	0·44	0·81	0·47	0·62	0·53	0·46	0·31
	1912	0·63	0·65	0·46	0·91	0·53	0·45	0·75	0·54	0·56	0·51	0·45	0·36
	1913	0·63	0·64	0·46	0·92	0·52	0·46	0·74	0·50	0·58	0·52	0·43	0·37
	1914	0·73	0·74	0·58	1·10	0·59	0·57	0·84	0·64	0·66	0·67	0·47	0·43
	1915	0·66	0·67	0·53	0·89	0·56	0·52	0·76	0·60	0·62	0·58	0·46	0·43
Cerebro-Spinal Fever	1913	0·01	0·01	0·00	0·02	0·01	0·00	0·01	0·01	0·01	0·00	0·01	0·00
	1914	0·01	0·01	0·00	0·02	0·01	0·00	0·01	0·01	0·00	0·01	0·01	—
	1915	0·07	0·08	0·04	0·14	0·07	0·03	0·06	0·07	0·07	0·03	0·07	0·02
Poliomyelitis	1913	0·02	0·02	0·01	0·03	0·02	0·01	0·02	0·01	0·02	0·01	0·01	0·01
	1914	0·01	0·01	0·00	0·02	0·01	0·00	0·02	0·01	0·01	0·00	0·01	—
	1915	0·01	0·02	0·01	0·02	0·02	0·01	0·01	0·01	0·02	0·00	0·01	0·01

Small-pox.—In England and Wales, 90 cases of small-pox were notified, as compared with 65 in 1914, 115 in 1913, 123 in 1912, and 295 in 1911. These figures include some cases notified which subsequently proved not to be small-pox.

31 cases were notified from towns connected with ports, viz., 29 at Bristol, and 1 each at Folkestone and Gravesend.

12 cases, as compared with 7 in 1914, 25 in 1913, 12 in 1912, and 30 in 1911, were notified to port sanitary authorities, being chiefly imported cases. Of these, 10 occurred in London, and 1 each in Bristol and Cardiff port sanitary districts.

Of the remaining 47 cases, 1 case was notified in each of 10 districts outside London, 3 were notified in Royton, 3 in Dewsbury, London had 11, of which Fulham had 7, Greenwich 2, Kensington 1, and Stepney 1, and 20 were notified in Oldham.

Typhus Fever.—45 cases of typhus fever were notified, as compared with 15 in 1914, 18 in 1913, 31 in 1912, and 65 in 1911. These figures include some cases notified which subsequently proved not to be typhus. The cases were notified from 6 sanitary districts, viz., 37 in Liverpool, 4 in Stepney, and 1 each in Hebburn, Newcastle-on-Tyne, Tynemouth, and London port sanitary district.

Scarlet Fever.—127,086 cases of scarlet fever were notified, as compared with 165,045 in 1914, 130,707 in 1913, 107,508 in 1912, and 104,651 in 1911.

Diphtheria.—53,597 cases of diphtheria were notified, as compared with 59,357 in 1914, 50,903 in 1913, 44,754 in 1912, and 47,802 in 1911.

Enteric Fever.—6,364 cases of enteric fever were notified, as compared with 8,778 in 1914, 8,263 in 1913, 8,386 in 1912, and 13,852 in 1911.

In nine instances Paratyphoid was specifically notified.

Continued Fever.—In addition to the above cases of enteric fever, 63 cases of "Continued fever," not otherwise defined, were notified.

Puerperal Fever.—2,057 cases of puerperal fever were notified, as compared with 2,338 in 1914, 1,989 in 1913, 2,184 in 1912, and 2,029 in 1911.

Erysipelas.—23,382 cases of erysipelas were notified, as compared with 26,977 in 1914, 23,132 in 1913, 22,886 in 1912, and 29,950 in 1911.

Cerebro-spinal Fever.—The total number of cases notified in England and Wales during the year 1915 was 2,566, as compared

with 315 in 1914, and 305 in 1913. The distribution of the cases is shown in the following table:—

—	London.	County Boroughs.	Boroughs and Urban Districts.	Rural Districts.	Port Sanitary Districts.	Total.
England	624	663	749	437	8	2,481
Wales (including Monmouth) ...	—	32	38	15	—	85
Total ...	624	695	787	452	8	2,566

The highest numbers of cases in administrative counties were notified in Middlesex, 115 cases, Southampton 110 cases, Wiltshire 108 cases, and Kent 106 cases. 624 cases were notified in London.

In county boroughs the highest numbers notified were Bristol 67, Portsmouth and Reading 63 each, and Birmingham 62.

Acute Poliomyelitis.—The total number of cases of poliomyelitis notified in England and Wales during 1915 was 517, as compared with 509 in 1914, and 729 in 1913. The distribution of the cases is shown in the following table:—

—	London.	County Boroughs.	Boroughs and Urban Districts.	Rural Districts.	Port Sanitary Districts.	Total.
England	98	132	192	80	—	502
Wales (including Monmouth) ...	—	4	4	7	—	15
Total ...	98	136	196	87	—	517

Ophthalmia Neonatorum.—During 1915, 6,806 cases of ophthalmia neonatorum were notified in England and Wales.

Tuberculosis.—The incidence of pulmonary and of other forms of tuberculosis since these diseases became compulsorily notifiable throughout England and Wales is shown in the following table. For reasons given on pages xcix-ci of my Annual Report for 1913-14, it has not been considered advisable to give statistics for smaller areas than those enumerated in the table on the next page. This table gives the aggregate of the total notifications returned weekly to the Board by medical officers of health. It includes a considerable number of duplicate notifications, the number of these varying greatly in different areas. The number of such duplicate notifications is particularly large in London. The rates given below must be considered in the light of these facts

An annual return is obtained by the Board from medical officers of health of administrative counties and county boroughs, in which all *known* duplicate notifications are excluded.

—	Pulmonary Tuberculosis. 1912. No. of cases notified.	Pulmonary Tuberculosis. 1912. Rate per 1000 of population.	1913. No. of cases notified.	1913. Rate per 1000 of population.	1914. No. of cases notified.	1914. Rate per 1000 of population.	1915. No. of cases notified.	1915. Rate per 1000 of population.	Other Tuberculosis. 1913 (11 months). No. of cases notified.	1913 (11 months). Annual rate per 1000 of population.	1914. No. of cases notified.	1914. Rate per 1000 of population.	1915. No. of cases notified.	1915. Rate per 1000 of population.
London	33,392	7·39	22,655	5·01	16,459	3·64	14,717	3·41	6,428	1·55	3,861	0·85	3,948	0·92
England (excluding London)	72,193	2·44	68,446	2·32	59,552	1·99	54,510	1·90	30,050	1·11	19,396	0·65	17,761	0·62
Wales (including Monmouth) ...	4,966	2·01	5,432	2·19	4,851	1·92	4,127	1·70	1,712	0·75	1,087	0·43	1,108	0·46
Total (including cases notified in Port Sanitary Districts).	110,706	3·03	96,841	2·65	81,159	2·20	73,538	2·07	38,200	1·14	24,366	0·66	22,864	0·65

I am again indebted to Dr. Stevenson, of the General Register Office, for arranging for the calculation of the rates given in the following tables. The populations given in the first column of the following tables have been estimated in the General Register Office.

I am, Sir,

Your obedient Servant,

ARTHUR NEWSHOLME,

Medical Officer.

March, 1916.

TABLE

Statistics of Infectious Diseases

——	Estimated Civil Population in the middle of 1915.	Scarlet Fever.		Diphtheria.		Enteric Fever.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
ENGLAND AND WALES* ...	35,359,749	127,086	3·59	53,597	1·52	6,364	0·18
ENGLAND	32,934,771	116,386	3·53	50,087	1·52	5,843	0·18
WALES (INCLUDING MONMOUTHSHIRE).	2,424,978	10,635	4·39	3,462	1·43	360	0·15
LONDON	4,310,030	16,975	3·94	9,094	2·11	599	0·14
ADMINISTRATIVE COUNTIES (ENGLAND AND WALES) EXCLUDING LONDON.	19,343,324	66,862	3·46	26,972	1·39	3,334	1·72
Bedfordshire	191,767	627	3·27	760	3·96	23	0·12
Berkshire	180,553	724	4·01	128	0·71	14	0·08
Buckinghamshire	214,727	488	2·27	206	0·96	20	0·09
Cambridgeshire	123,297	250	2·03	129	1·05	5	0·04
Isle of Ely	69,247	132	1·91	114	1·65	24	0·35
Cheshire	591,740	2,016	3·41	670	1·13	86	0·15
Cornwall	307,626	637	2·07	699	2·27	43	0·14
Cumberland	204,939	1,151	5·62	215	1·05	15	0·07
Derbyshire	553,990	2,703	4·88	966	1·74	94	0·17
10–Devonshire	400,985	1,089	2·72	746	1·86	59	0·15
Dorsetshire	206,982	399	1·93	177	0·86	19	0·09
Durham	855,245	4,117	4·81	1,599	1·87	249	0·29
Essex	860,695	2,911	3·38	1,212	1·41	97	0·11
Gloucestershire	311,767	1,165	3·74	519	1·67	32	0·10
Herefordshire	106,879	337	3·15	118	1·10	11	0 10
Hertfordshire	305,122	681	2·23	480	1·57	18	0·06
Huntingdonshire	53,246	97	1·82	18	0·34	1	0·02
Kent	985,147	2,823	2·87	2,076	2·11	214	0·22
Lancashire	1,666,488	7,479	4·49	1,508	0·91	524	0·31
20–Leicestershire	249,107	515	2·07	265	1·06	21	0·08
Lincolnshire—Holland ...	81,052	418	5·16	93	1·15	7	0·09
" Kesteven ...	106,814	193	1·81	214	2·00	11	0·10
" Lindsey ...	234,483	544	2·32	231	0·99	29	0·12
Middlesex	1,184,250	3,785	3·20	1,799	1·52	139	0·12
Norfolk	303,780	1,044	3·44	255	0·84	61	0·20
Northamptonshire	210,360	510	2·42	639	3·04	25	0·12
Soke of Peterborough ...	45,968	210	4·57	44	0·96	2	0·04
Northumberland	364,347	1,628	4·47	520	1·43	80	0·22
Nottinghamshire	353,193	1,106	3·13	489	1·38	40	0·11
30–Oxfordshire	126,412	354	2·80	45	0·36	3	0·02
Rutlandshire	18,420	20	1·09	39	2·12	1	0·05
Shropshire	232,508	511	2·20	325	1·40	7	0·03
Somersetshire	368,858	830	2·25	373	1·01	36	0·10
Southampton	395,648	1,046	2·64	633	1·60	48	0·12
Isle of Wight	79,269	169	2·13	52	0·66	19	0·24
Staffordshire	666,208	2,265	3·40	775	1·16	59	0·09
Suffolk—East	190,909	587	3·07	197	1·03	48	0·25
" West	107,772	303	2·81	124	1·15	3	0·03
Surrey	662,282	2,063	3·11	819	1·24	103	0·16
40–Sussex—East	226,746	360	1·59	179	0·79	15	0·07
" West	164,207	395	2·41	267	1·63	24	0·15
Warwickshire	308,012	1,039	3·37	203	0·66	29	0·09
Westmorland	60,741	109	1·79	24	0·40	32	0·53
Wiltshire	280,519	1,274	4·54	434	1·55	25	0·09
Worcestershire	280,212	1,013	3·62	350	1·25	20	0·07
Yorkshire—East Riding ...	150,176	271	1·80	147	0·98	20	0·13
" North Riding...	285,614	735	2·57	383	1·34	54	0·19
" West Riding ...	1,442,652	4,541	3·15	1,996	1·38	511	0·35
AGGREGATE OF ENGLISH ADMINISTRATIVE COUNTIES (EXCLUDING LONDON).	17,370,961	57,664	3·32	24,254	1·40	3,020	0·17

* Including

I.

in Administrative Counties.

Puerperal Fever.		Erysipelas.		Small-pox cases.	Typhus Fever cases.	Continued Fever cases.	Cerebro-spinal Fever cases.	Polio-myelitis cases.	Ophthalmia Neonatorum cases.	Pulmonary Tuberculosis cases.	Other Tuberculosis cases.
Cases.	Rate.	Cases.	Rate.								
2,057	0·06	23,382	0·66	90	45	63	2,566	517	6,806	73,538	22,864
1,886	0·06	22,055	0·67	78	44	51	2,473	502	6,495	69,227	21,709
171	0·07	1,291	0·53	—	—	6	85	15	307	4,127	1,108
278	0·06	3,841	0·89	11	4	12	624	98	741	14,717	3,948
875	0·05	10,728	0·55	13	1	33	1,239	283	2,120	28,337	9,444
16	0·08	110	0·57	—	—	—	6	2	22	354	77
11	0·06	63	0·35	—	—	—	24	—	12	290	38
5	0·02	87	0·41	—	—	—	12	3	12	185	44
6	0·05	59	0·48	—	—	—	2	2	8	281	43
1	0·01	48	0·69	—	—	—	5	—	7	83	25
28	0·05	325	0·55	1	—	—	8	4	58	741	327
7	0·02	144	0·47	—	—	1	37	10	14	376	145
5	0·02	144	0·70	—	—	—	3	5	29	274	89
41	0·07	313	0·56	—	—	—	14	9	47	700	277
15	0·04	135	0·34	—	—	—	24	7	13	611	96–10
12	0·06	72	0·35	—	—	—	46	4	16	198	37
38	0·04	582	0·68	—	1	5	8	9	108	1,656	1,133
24	0·03	488	0·57	1	—	—	85	11	84	1,283	456
6	0·02	160	0·51	—	—	—	28	10	32	459	125
3	0·03	82	0·77	—	—	1	5	1	12	214	38
16	0·05	142	0·47	—	—	—	22	6	11	437	99
4	0·08	15	0·28	—	—	—	10	2	2	77	20
32	0·03	603	0·61	2	—	1	106	15	110	1,351	436
87	0·05	1,197	0·72	3	—	4	44	13	252	2,946	1,146
9	0·04	217	0·87	—	—	—	9	—	23	329	123–20
2	0·02	45	0·56	—	—	—	3	—	2	81	20
5	0·05	41	0·38	—	—	—	2	1	4	129	42
2	0·01	114	0·49	—	—	—	6	3	15	261	87
52	0·04	731	0·62	1	—	—	115	63	146	2,143	589
5	0·02	74	0·24	—	—	—	24	1	20	236	69
12	0·06	142	0·68	—	—	1	16	1	22	388	53
3	0·07	21	0·46	—	—	—	6	1	6	53	15
8	0·02	200	0·55	—	—	3	8	13	46	469	193
19	0·05	229	0·65	—	—	1	8	5	37	366	103
3	0·02	67	0·53	—	—	—	7	1	4	186	51–30
—	—	11	0·60	—	—	—	—	—	4	10	11
12	0·05	90	0·39	—	—	—	3	—	28	372	70
8	0·02	151	0·41	—	—	—	37	5	30	725	121
14	0·04	177	0·45	—	—	1	110	6	45	404	111
2	0·03	22	0·28	—	—	—	8	1	13	63	15
37	0·06	390	0·59	1	—	—	13	4	88	1,099	282
9	0·05	77	0·40	—	—	—	20	1	24	242	43
1	0·01	41	0·38	—	—	—	9	5	1	157	54
36	0·05	297	0·45	—	—	3	67	26	56	918	192
9	0·04	79	0·35	—	—	—	23	5	17	346	103–40
4	0·02	58	0·35	—	—	—	14	1	14	244	56
21	0·07	158	0·51	2	—	—	44	4	52	417	138
3	0·05	34	0·56	—	—	1	3	1	4	66	8
11	0·04	126	0·45	—	—	1	108	3	15	314	91
13	0·05	153	0·55	—	—	—	10	—	47	501	131
4	0·03	101	0·67	—	—	—	3	—	11	134	60
5	0·02	149	0·52	—	—	3	8	2	16	266	92
69	0·05	945	0·66	2	—	2	13	6	264	1,902	1,013
735	0·04	9,709	0·56	13	1	28	1,186	272	1,897	25,367	8,587

Port cases.

—	Estimated Civil Population in the middle of 1915.	Scarlet Fever.		Diphtheria.		Enteric Fever.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
Anglesey	49,647	166	3·34	46	0·93	6	0·12
50–Brecknockshire	58,389	207	3·55	121	2·07	15	0·26
Cardiganshire	57,323	207	3·61	50	0·87	6	0·10
Carmarthenshire	163,622	1,031	6·30	148	0·90	14	0·09
Carnarvonshire	116,633	212	1·82	98	0·84	11	0·09
Denbighshire	140,756	308	2·19	159	1·13	9	0·06
Flintshire	92,944	367	3·95	438	4·71	15	0·16
Glamorganshire	766,720	3,825	4·99	1,170	1·53	148	0·19
Merionethshire	42,378	123	2·90	43	1·01	2	0·05
Monmouthshire	323,882	2,360	7·29	329	1·02	63	0·19
Montgomeryshire	50,473	65	1·29	20	0·40	2	0·04
60–Pembrokeshire	87,825	290	3·30	76	0·87	22	0·25
Radnorshire	21,771	37	1·70	20	0·92	1	0·05
AGGREGATE OF WELSH ADMINISTRATIVE COUNTIES (INCLUDING MONMOUTHSHIRE).	1,972,363	9,198	4·66	2,718	1·38	314	0·16
PORT SANITARY DISTRICTS	—	65	—	48	—	161	—
NAVAL AND MILITARY CASES NOTIFIED TO MEDICAL OFFICERS OF HEALTH (NOT INCLUDED IN THE ABOVE TOTAL FOR ENGLAND AND WALES).	—	1,998	—	1,183	—	594	—

IN ADMINISTRATIVE COUNTIES—*cont.*

Puerperal Fever.		Erysipelas.		Small-pox cases.	Typhus Fever cases.	Continued Fever cases.	Cerebro-spinal Fever cases.	Poliomyelitis cases.	Ophthalmia Neonatorum cases.	Pulmonary Tuberculosis cases.	Other Tuberculosis cases.
Cases.	Rate.	Cases.	Rate.								
1	0·02	6	0·12	—	—	—	1	—	4	63	18
7	0·12	32	0·55	—	—	—	—	—	6	51	13-50
3	0·05	23	0·40	—	—	—	—	—	2	108	22
21	0·13	87	0·53	—	—	—	4	4	7	257	93
4	0·03	58	0·50	—	—	—	2	—	2	192	66
5	0·04	49	0·35	—	—	—	1	—	18	173	81
7	0·08	49	0·53	—	—	1	7	—	4	76	16
59	0·08	430	0·56	—	—	4	26	1	97	1,051	270
—	—	37	0·87	—	—	—	2	—	1	94	23
23	0·07	194	0·60	—	—	—	6	3	80	699	209
—	—	19	0·38	—	—	—	—	1	—	73	25
7	0·08	34	0·39	—	—	—	2	—	2	108	17-60
3	0·14	1	0·05	—	—	—	2	2	—	25	4
140	0·07	1,019	0·52	—	—	5	53	11	223	2,970	857
—	—	36	—	12	1	6	8	—	4	184	47
—	—	264	—	2	1	3	930	3	—	516	64

Statistics of Infectious

	Estimated Civil Population in the middle of 1915.	Scarlet Fever.		Diphtheria.		Enteric Fever.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
AGGREGATE OF 82 COUNTY BOROUGHS.	11,706,395	43,184	3·69	17,483	1·49	2,270	0·19
Barnsley	50,409	153	3·04	43	0·85	7	0·14
Barrow-in-Furness	83,051	177	2·13	118	1·42	2	0·02
Bath, City of..	63,452	191	3·01	119	1·88	7	0·11
Birkenhead	134,913	300	2·22	80	0·59	20	0·15
Birmingham, City of	864,545	3,141	3·63	1,237	1·43	37	0·04
Blackburn	127,443	460	3·61	39	0·31	44	0·35
Blackpool	64,208	318	4·95	33	0·51	34	0·53
Bolton	172,514	575	3·33	178	1·03	48	0·28
Bootle	71,617	269	3·76	72	1·01	16	0·22
10-Bournemouth	72,197	117	1·62	84	1·16	2	0·03
Bradford, City of	280,737	497	1·77	424	1·51	96	0·34
Brighton	118,286	219	1·85	120	1·01	18	0·15
Bristol, City of	352,859	1,071	3·04	502	1·42	45	0·13
Burnley	103,098	414	4·02	102	0·99	21	0·20
Burton-upon-Trent	45,786	100	2·18	44	0·96	1	0·02
Bury	54,773	156	2·85	48	0·88	10	0·18
Canterbury, City of	24,595	94	3·82	119	4·84	6	0·24
Carlisle, City of	50,036	564	11·27	68	1·36	2	0·04
Chester, City of	37,479	57	1·52	73	1·95	1	0·03
20-Coventry, City of	120,529	654	5·43	209	1·73	7	0·06
Croydon	177,345	407	2·29	191	1·08	21	0·12
Darlington	60,268	162	2·71	135	2·26	7	0·12
Derby	119,072	815	6·84	296	2·49	16	0·13
Dewsbury	53,299	195	3·66	18	0·34	8	0·15
Dudley..	50,849	242	4·76	3	0·06	3	0·06
Eastbourne	47,125	175	3·71	144	3·06	5	0·11
East Ham	142,582	496	3·48	207	1·45	5	0·04
Exeter, City of	55,460	64	1·15	62	1·12	20	0·36
Gateshead	120,850	446	3·69	81	0·67	24	0·20
30-Gloucester, City of..	48,139	96	1·99	104	2·16	1	0·02
Great Yarmouth	50,475	112	2·22	123	2·44	14	0·28
Grimsby	72,126	145	2·01	80	1·11	14	0·19
Halifax	99,497	264	2·65	87	0·87	26	0·26
Hastings	52,053	97	1·86	89	1·71	1	0·02
Huddersfield..	111,139	373	3·36	173	1·56	8	0·07
Ipswich	74,251	542	7·30	102	1·37	16	0·22
Kingston-upon-Hull, City of ..	269,530	574	2·13	649	2·41	91	0·34
Leeds, City of	446,349	1,441	3·23	396	0·89	108	0·24
Leicester	225,907	333	1·47	153	0·68	14	0·06
40-Lincoln, City of	55,226	118	2·14	59	1·07	3	0·05
Liverpool, City of	740,162	2,975	4·02	1,206	1·63	105	0·14
Manchester, City of	700,319	2,995	4·28	572	0·82	173	0·25
Middlesbrough	116,901	328	2·81	259	2·22	16	0·14
Newcastle-upon-Tyne, City of..	278,107	1,337	4·81	243	0·87	90	0·32
Northampton	90,296	685	7·59	306	3·39	18	0·20
Norwich, City of	115,902	240	2·07	305	2·63	23	0·20
Nottingham, City of	240,588	1,235	5·13	182	0·76	29	0·12
Oldham	141,781	535	3·77	85	0·60	11	0·08
Oxford, City of	49,027	42	0·86	24	0·49	4	0·08
50-Plymouth	187,911	380	2·02	350	1·86	81	0·43
Portsmouth	202,441	832	4·11	908	4·49	95	0·47
Preston..	111,936	692	6·18	197	1·76	44	0·39
Reading	86,299	198	2·29	57	0·66	17	0·20
Rochdale	90,653	137	1·51	513	5·66	22	0·24
Rotherham	64,324	337	5·24	85	1·32	32	0·50
St. Helen's	92,240	505	5·47	282	3·06	28	0·30
Salford..	219,979	996	4·53	235	1·07	79	0·36
Sheffield, City of	476,012	2,172	4·56	1,020	2·14	63	0·13
Smethwick	72,439	252	3·48	57	0·79	—	—
60-Southampton	117,349	426	3·63	346	2·95	25	0·21
Southend-on-Sea	76,382	159	2·08	70	0·92	7	0·09
Southport	65,866	303	4·60	74	1·12	5	0·08
South Shields	109,855	922	8·39	34	0·31	9	0·08
Stockport	120,030	685	5·71	98	0·82	26	0·22
Stoke-on-Trent	225,405	871	3·86	933	4·14	48	0·21
Sunderland	148,273	254	1·71	108	0·73	15	0·10
Tynemouth	58,199	130	2·23	61	1·05	122	0·10
Wakefield	48,407	51	1·05	93	1·92	16	0·33
Wallasey	84,875	208	2·45	88	1·04	14	0·16
70-Walsall..	92,045	236	2·56	68	0·74	8	0·09
Warrington	72,297	944	13·06	90	1·24	36	0·50
West Bromwich	68,402	108	1·58	54	0·79	1	0·01
West Ham	294,396	733	2·49	476	1·62	54	0·18
West Hartlepool	63,463	77	1·21	40	0·63	11	0·17
Wigan	86,329	1,608	18·63	37	0·43	45	0·52
Wolverhampton	94,968	206	2·17	140	1·47	3	0·03
Worcester, City of	46,071	83	1·80	75	1·63	6	0·13
York, City of..	79,802	246	3·08	104	1·30	14	0·18
AGGREGATE OF 78 COUNTY BOROUGHS IN ENGLAND.	11,253,780	41,747	3·71	16,739	1·49	2,224	0·20
Cardiff	184,900	752	4·07	472	2·55	20	0·11
80-Merthyr Tydfil	76,493	186	2·43	51	0·67	6	0·08
Newport (Mon.)	80,379	202	2·51	92	1·14	10	0·12
Swansea	110,843	297	2·68	129	1·16	10	0·09
AGGREGATE OF 4 COUNTY BOROUGHS IN WALES AND MONMOUTH.	452,615	1,437	3·17	744	1·64	46	0·10

Diseases in County Boroughs.

Puerperal Fever.		Erysipelas.		Small-pox Cases	Ty-phus Fever Cases.	Con-tinued Fever Cases.	Cere-bro-spinal Fever Cases.	Polio-mye-litis Cases.	Oph-thalmia Neona-torum Cases.	Pul-monary Tuber-culosis Cases.	Other Tuber-culosis Cases.
Cases.	Rate.	Cases	Rate.								
904	0·08	8,777	0·75	54	39	12	695	136	3,941	30,300	9,425
3	0·06	48	0·95	—	—	—	3	—	15	130	12
—	—	67	0·81	—	—	—	—	—	4	116	20
3	0·05	51	0·80	—	—	—	14	—	7	123	22
12	0·09	106	0·79	—	—	—	4	1	90	292	128
157	0·18	735	0·85	—	—	—	62	7	326	3,118	527
5	0·04	69	0·54	—	—	—	—	—	4	210	96
8	0·12	27	0·42	—	—	—	1	—	11	163	25
2	0·01	149	0·86	—	—	—	2	1	24	267	61
3	0·04	40	0·56	—	—	—	2	1	19	230	89
—	—	25	0·35	—	—	—	12	—	14	187	22-10
30	0·11	237	0·84	—	—	—	1	—	87	518	275
2	0·02	61	0·52	—	—	—	36	27	24	3[illegible]2	101
28	0·08	260	0·74	29	—	—	67	13	95	801	206
7	0·07	126	1·22	—	—	—	—	—	21	157	68
2	0·01	38	0·83	—	—	—	—	—	28	98	36
3	0·05	48	0·88	—	—	—	—	—	16	125	26
1	0·04	20	0·81	—	—	—	7	1	10	17	1
1	0·02	72	1·44	—	—	—	—	3	17	198	52
4	0·11	12	0·32	—	—	—	2	—	5	32	23
7	0·06	89	0·74	—	—	—	7	—	25	421	63-20
12	0·07	81	0·46	—	—	—	26	3	32	405	161
2	0·03	44	0·74	—	—	—	1	—	20	107	58
10	0·08	93	0·78	—	—	—	9	1	94	198	65
4	0·08	26	0·49	3	—	—	—	—	17	106	24
1	0·02	43	0·85	—	—	—	—	1	10	62	28
5	0·11	16	0·34	—	—	—	10	—	7	124	25
4	0·03	96	0·67	—	—	—	8	1	16	354	81
2	0·04	25	0·45	—	—	—	5	—	14	115	25
5	0·04	95	0·79	—	—	—	—	3	35	346	209
2	0·04	35	0·73	—	—	—	1	2	8	82	21-30
1	0·02	36	0·71	—	—	—	—	1	11	72	13
2	0·03	14	0·19	—	—	—	—	—	11	97	34
2	0·02	58	0·58	—	—	1	1	—	11	143	65
3	0·06	26	0·50	—	—	—	5	1	14	85	10
2	0·02	57	0·51	—	—	—	1	2	33	157	66
3	0·04	41	0·55	—	—	—	22	1	17	110	38
19	0·07	184	0·68	—	—	1	6	—	80	466	141
21	0·05	347	0·78	1	—	—	3	1	81	1,098	315
21	0·09	335	1·48	—	—	—	5	2	67	880	155
1	0·02	40	0·72	—	—	—	1	—	2	103	46-40
54	0·07	751	1·01	—	37	—	29	5	495	2,169	825
103	0·15	492	0·70	—	—	—	18	7	584	2,438	844
3	0·03	58	0·50	—	—	—	2	—	25	560	218
21	0·08	170	0·61	—	1	4	9	7	24	613	353
8	0·09	96	1·06	—	—	—	13	3	18	215	43
7	0·06	49	0·42	—	—	—	19	—	19	160	21
8	0·03	221	0·92	—	—	1	9	—	126	334	42
11	0·08	137	0·97	20	—	—	4	—	18	358	137
2	0·04	21	0·43	—	—	—	1	—	11	78	34
9	0·05	194	1·03	—	—	1	20	2	21	385	111-50
6	0·03	115	0·57	—	—	1	63	—	26	635	238
9	0·08	82	0·73	—	—	—	10	—	21	341	52
12	0·14	49	0·57	—	—	—	63	—	17	235	25
—	—	80	0·88	—	—	—	2	1	19	187	132
8	0·12	47	0·73	—	—	—	—	—	18	123	53
11	0·12	75	0·81	—	—	—	8	—	79	211	137
22	0·10	169	0·77	1	—	—	9	7	98	1,023	207
63	0·13	391	0·82	—	—	—	3	7	195	1,193	367
9	0·12	48	0·66	—	—	—	5	—	16	227	101
5	0·04	58	0·49	—	—	—	13	1	21	329	78-60
7	0·09	29	0·38	—	—	—	4	4	11	198	48
6	0·09	42	0·64	—	—	—	—	—	7	103	42
4	0·04	58	0·53	—	—	1	1	2	36	431	234
4	0 03	63	0·52	—	—	—	—	1	22	165	111
21	0·09	202	0·90	—	—	—	1	—	247	705	133
10	0·07	95	0·64	—	—	—	1	1	28	431	242
2	0·03	45	0·77	—	1	1	1	—	21	103	53
4	0·08	26	0·54	—	—	—	—	—	8	120	35
2	0·02	35	0·41	—	—	—	1	—	6	117	32
5	0·05	81	0·88	—	—	—	1	2	40	477	102-70
5	0·07	59	0·82	—	—	—	1	—	14	161	79
6	0·09	34	0·50	—	—	—	1	1	5	200	71
8	0·03	228	0·77	—	—	—	23	5	42	637	191
1	0·02	36	0·57	—	—	—	—	1	23	172	85
5	0·06	81	0·94	—	—	—	—	1	33	234	107
2	0·02	63	0·66	—	—	—	2	1	13	228	50
4	0·09	23	0·50	—	—	—	2	—	17	83	37
6	0·08	30	0·38	—	—	—	—	—	11	139	71
873	0·08	8,505	0·76	54	39	11	663	132	3,857	29,143	9,174
12	0·06	104	0·56	—	—	1	23	3	46	375	103
7	0·09	60	0·78	—	—	—	2	—	6	159	40-80
9	0·11	47	0·58	—	—	—	2	—	14	197	61
3	0·03	61	0·55	—	—	—	5	1	18	426	47
31	0·07	272	0·60	—	—	1	32	4	81	1,157	251

TABLE showing the number of cases of certain INFECTIOUS DISEASES notified in each sanitary area in ENGLAND and WALES during the 52 weeks ended 1st January, 1916 and the ATTACK-RATES per 1000 of the population.

Cases of Membranous Croup are included under the heading of Diphtheria.

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of London.													
ADMINISTRATIVE COUNTY	4,310,030	11	0·00	16975	3·94	9,091	2·11	599	0·14	278	0·06	3,841	0·89
CITY OF LONDON	19,461	–	–	57	2·93	48	2·47	2	0·10	–	–	5	0·26
METROPOLITAN BOROUGHS :—													
Battersea	161,945	–	–	672	4·15	394	2·43	25	0·15	5	0·03	141	0·87
Bermondsey	117,188	–	–	365	3·11	225	1·92	20	0·17	7	0·06	125	1·07
Bethnal Green	120,207	–	–	786	6·54	532	4·43	18	0·15	9	0·07	196	1·63
Camberwell..	254,385	–	–	850	3·34	404	1·59	26	0·10	16	0·06	211	0·83
Chelsea	58,421	–	–	142	2·43	105	1·80	17	0·29	5	0·09	33	0·56
Deptford	110,299	–	–	438	3·97	200	1·81	37	0·34	4	0·04	150	1·36
Finsbury	76,915	–	–	441	5·73	133	1·73	6	0·08	6	0·08	57	0·74
Fulham	151,161	7	0·05	618	4·09	268	1·77	13	0·09	24	0·16	91	0·60
Greenwich	96,385	2	0·02	508	5·27	170	1·76	18	0·19	4	0·04	103	1·07
Hackney	217,883	–	–	762	3·50	406	1·86	39	0·18	9	0·04	223	1·02
Hammersmith	118,559	–	–	416	3·51	185	1·56	22	0·19	5	0·04	92	0·78
Hampstead	81,760	–	–	191	2·34	137	1·68	12	0·15	3	0·04	52	0·64
Holborn	40,405	–	–	153	3·79	68	1·68	6	0·15	2	0·05	28	0·69
Islington	316,242	–	–	1332	4·21	626	1·98	27	0·09	23	0·07	203	0·64
Kensington	155,795	1	0·01	426	2·73	174	1·12	19	0·12	12	0·08	87	0·56
Lambeth	284,188	–	–	898	3·16	430	1·51	26	0·09	27	0·10	174	0·61
Lewisham	164,438	–	–	476	2·89	250	1·52	16	0·10	4	0·02	103	0·63
Paddington	131,397	–	–	435	3·31	282	2·15	18	0·14	7	0·05	138	1·05
Poplar	156,247	–	–	475	3·04	308	1·97	18	0·12	14	0·09	188	1·20
St. Marylebone	100,260	–	–	303	3·02	136	1·36	11	0·11	3	0·03	81	0·81
St. Pancras	200,322	–	–	1006	5·02	438	2·19	28	0·14	13	0·06	201	1·00
Shoreditch	103,627	–	–	556	5·37	272	2·62	21	0·20	9	0·09	183	1·77
Southwark	179,424	–	–	465	2·59	387	2·16	23	0·13	26	0·14	254	1·42
*Stepney	265,731	1	0·00	1535	5·78	1108	4·17	37	0·14	13	0·05	298	1·12
Stoke Newington	50,527	–	–	199	3·94	107	2·12	4	0·08	2	0·04	39	0·77
Wandsworth	312,249	–	–	1300	4·16	727	2·33	50	0·16	11	0·04	191	0·61
Westminster	135,104	–	–	607	4·49	296	2·19	13	0·10	9	0·07	69	0·51
Woolwich	129,505	–	–	563	4·35	278	2·15	27	0·21	6	0·05	125	0·97
County of Bedford.													
ADMINISTRATIVE COUNTY	191,767	–	–	627	3·27	760	3·96	23	0·12	16	0·08	110	0·57
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	117,418	–	–	341	2·90	587	5·00	17	0·14	11	0·09	74	0·63
AGGREGATE OF RURAL DISTRICTS.	74,349	–	–	286	3·85	173	2·33	6	0·08	5	0·07	36	0·48
BOROUGHS AND URBAN DISTRICTS :—													
Ampthill	2,188	–	–	1	0·46	3	1·37	–	–	–	–	1	0·46
Bedford	37,113	–	–	134	3·61	132	3·56	1	0·03	6	0·16	18	0·49
Biggleswade .. .	5,182	–	–	11	2·12	4	0·77	1	0·19	–	–	–	–
Dunstable	7,845	–	–	14	1·78	14	1·78	1	0·13	1	0·13	–	–
Kempston	4,714	–	–	25	5·30	84	17·82	–	–	–	–	–	–
Leighton Buzzard ..	6,451	–	–	26	4·03	46	7·13	6	0·93	1	0·16	5	0·78
Luton	53,925	–	–	130	2·41	304	5·64	8	0·15	3	0·06	50	0·93
RURAL DISTRICTS :—													
Ampthill	18,705	–	–	57	3·05	41	2·19	1	0·05	2	0·11	10	0·53
Bedford	18,588	–	–	121	6·51	59	3·17	–	–	–	–	3	0·16
Biggleswade	20,083	–	–	79	3·93	18	0·90	5	0·25	2	0·10	22	1·10
Eaton Bray	3,731	–	–	8	2·14	13	3·48	–	–	–	–	–	–
Eaton Socon	3,267	–	–	–	–	–	–	–	–	–	–	–	–
Luton	9,975	–	–	21	2·11	42	4·21	–	–	1	0·10	1	0·10

* Four cases of Typhus Fever were notified.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Berks.													
ADMINISTRATIVE COUNTY	180,553	–	–	724	4·01	128	0·71	14	0·08	11	0·06	63	0·35
COUNTY BOROUGH :— Reading	86,299	–	–	193	2·24	57	0·66	17	0·20	12	0·14	49	0·57
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	53,467	–	–	250	4·68	54	1·01	1	0·02	5	0·09	29	0·54
AGGREGATE OF RURAL DISTRICTS.	127,086	–	–	474	3·73	74	0·58	13	0·10	6	0·05	34	0·27
BOROUGHS AND URBAN DISTRICTS :—													
Abingdon	6,331	–	–	11	1·74	4	0·63	–	–	–	–	4	0·63
Maidenhead	15,031	–	–	100	6·65	10	0·67	–	–	3	0·20	4	0·27
Newbury	11,525	–	–	74	6·42	30	2·60	–	–	2	0·17	2	0·17
New Windsor	10,547	–	–	30	2·84	4	0·38	1	0·09	–	–	5	0·47
Wallingford	2,551	–	–	1	0·39	–	–	–	–	–	–	1	0·39
Wantage	3,516	–	–	27	7·68	3	0·85	–	–	–	–	8	2·28
Wokingham	3,966	–	–	7	1·77	3	0·76	–	–	–	–	5	1·26
RURAL DISTRICTS.—													
Abingdon	9,158	–	–	19	2·07	6	0·66	1	0·11	–	–	2	0·22
Bradfield	13,180	–	–	28	2·12	11	0·83	–	–	–	–	2	0·15
Cookham	12,423	–	–	93	7·49	7	0·56	–	–	1	0·08	5	0·40
Easthampstead	14,993	–	–	70	4·67	2	0·13		–	2	0·13	1	0·07
*Faringdon (part of) ..	10,028	–	–	61	6·08	–	–	1	0·10	1	0·10	3	0·30
Hungerford	8,174	–	–	24	2·94	3	0·37	–	–	1	0·12	1	0·12
Newbury	10,525	–	–	38	3·61	16	1·52	5	0·48	–	–	2	0·19
Wallingford	6,351	–	–	19	2·99	7	1·10	4	0·63	–	–	2	0·31
Wantage	11,327	–	–	51	4·50	9	0·79	1	0·09	–	–	6	0·53
Windsor	14,216	–	–	30	2·11	7	0·49	–	–	1	0·07	4	0·28
Wokingham	16,681	–	–	41	2·46	6	0·36	1	0·06	–	–	6	0·36
County of Buckingham.													
ADMINISTRATIVE COUNTY	214,727	–	–	488	2·27	206	0·96	20	0·09	5	0·02	87	0·41
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	77,271	–	–	265	3·43	82	1·06	5	0·06	3	0·04	32	0·41
AGGREGATE OF RURAL DISTRICTS.	137,456	–	–	223	1·62	124	0·90	15	0·11	2	0·01	55	0·40
BOROUGHS AND URBAN DISTRICTS :—													
Aylesbury	10,786	–	–	67	6·21	28	2·60	–	–	1	0·09	12	1·11
Beaconsfield	3,191	–	–	3	0·94	–	–	3	0·94	–	–	2	0·63
Bletchley	4,941	–	–	14	2·83	5	1·01	1	0·20	–	–	2	0·40
Buckingham	3,038	–	–	8	2·63	4	1·32	–	–	–	–	2	0·66
Chepping Wycombe ..	19,933	–	–	125	6·27	19	0·95	1	0·05	2	0·10	7	0·35
Chesham	7,964	–	–	5	0·63	1	0·13	–	–	–	–	1	0·13
Eton	2,125	–	–	3	1·41	–	–	–	–	–	–	1	0·47
Linslade	2,204	–	–	–	–	10	4·54	–	–	–	–	–	–
Marlow	4,617	–	–	26	5·63	–	–	–	–	–	–	–	–
Newport Pagnell	4,054	–	–	4	0·99	5	1·23	–	–	–	–	–	–
Slough	14,418	–	–	10	0·69	10	0·69	–	–	–	–	5	0·35
RURAL DISTRICTS :—													
Amersham	17,854	–	–	10	0·56	3	0·17	2	0·11	–	–	5	0·28
Aylesbury	14,588	–	–	34	2·33	1	0·07	–	–	–	–	3	0·21
Buckingham	7,804	–	–	17	2·18	2	0·26	–	–	–	–	–	–
Eton	24,812	–	–	28	1·13	31	1·25	–	–	–	–	4	0·16
Hambleden	1,870	–	–	1	0·53	2	1·07	2	1·07	1	0·53	1	0·53
Long Crendon	3,884	–	–	7	1·80	4	1·03	–	–	–	–	2	0·51
Newport Pagnell	18,371	–	–	48	2·61	44	2·40	6	0·33	–	–	24	1·31
Stratford and Wolverton	10,635	–	–	15	1·41	8	0·75	5	0·47	–	–	8	0·75
Wing	5,802	–	–	5	0·86	1	0·17	–	–	–	–	1	0·17
Winslow	6,626	–	–	12	1·81	11	1·66	–	–	–	–	2	0·30
Wycombe	25,210	–	–	46	1·82	17	0·67	–	–	1	0·04	5	0·20

* The remaining part of the Rural District of Faringdon is in the Administrative County of Gloucester. The figures for the entire district are :—

11,081	–	–	61	5·50	–	–	1	0·09	1	0·09	3	0·27

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Cambridge.													
ADMINISTRATIVE COUNTY	123,297	–	–	250	2·03	129	1·05	5	0·04	6	0·05	59	0·48
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	54,029	–	–	76	1·41	69	1·28	2	0·04	4	0·07	16	0·30
AGGREGATE OF RURAL DISTRICTS.	69,268	–	–	174	2·51	60	0·87	3	0·04	2	0·03	43	0·62
BOROUGHS AND URBAN DISTRICTS:—													
Cambridge	54,029	–	–	76	1·41	69	1·28	2	0·04	4	0·07	16	0·30
RURAL DISTRICTS:—													
Caxton and Arrington ..	7,155	–	–	32	4·47	–	–	–	–	1	0·14	4	0·56
Chesterton	22,485	–	–	73	3·25	22	0·98	1	0·04	–	–	14	0·62
Linton..	9,664	–	–	19	1·97	20	2·07	–	–	–	–	13	1·35
Melbourn	8,287	–	–	18	2·17	7	0·84	–	–	–	–	2	0·24
Newmarket	19,217	–	–	28	1·46	11	0·57	2	0·10	1	0·05	9	0·47
Swavesey	2,460	–	–	4	1·63	–	–	–	–	–	–	1	0·41
County of Isle of Ely.													
ADMINISTRATIVE COUNTY	69,247	–	–	132	1·91	114	1·65	24	0·35	1	0·01	48	0·69
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	35,815	–	–	98	2·74	82	2·29	12	0·34	–	–	29	0·81
AGGREGATE OF RURAL DISTRICTS.	33,432	–	–	34	1·02	32	0·96	12	0·36	1	0·03	19	0·57
BOROUGHS AND URBAN DISTRICTS:—													
Chatteris	5,103	–	–	3	0·59	34	6·66	3	0·59	–	–	6	1·18
Ely	7,468	–	–	41	5·49	30	4·02	4	0·54	–	–	6	0·80
March..	8,481	–	–	19	2·24	1	0·12	–	–	–	–	4	0·47
Whittlesey	4,084	–	–	30	7·35	11	2·69	–	–	–	–	4	0·98
Wisbech	10,679	–	–	5	0·47	6	0·56	5	0·47	–	–	9	0·84
RURAL DISTRICTS:—													
Ely	12,804	–	–	11	0·86	12	0·94	6	0·47	–	–	7	0·55
North Witchford	4,941	–	–	2	0·40	–	–	1	0·20	1	0·20	5	1·01
Thorney	2,045	–	–	1	0·49	5	2·44	1	0·49	–	–	2	0·98
Whittlesey	3,269	–	–	5	1·53	6	1·84	–	–	–	–	3	0·92
Wisbech	10,373	–	–	15	1·45	9	0·87	4	0·39	–	–	2	0·19
County of Chester.													
ADMINISTRATIVE COUNTY	591,740	1	0·00	2,016	3·41	670	1·13	86	0·15	28	0·05	325	0·55
COUNTY BOROUGHS:—													
Birkenhead	134,913	–	–	300	2·22	80	0·59	20	0·15	12	0·09	106	0·79
Chester	37,479	–	–	57	1·52	73	1·95	1	0·03	4	0·11	12	0·32
Stockport	120,030	–	–	685	5·71	98	0·82	26	0·22	4	0·03	63	0·52
Wallasey	84,875	–	–	208	2·45	88	1·04	14	0·16	2	0·02	35	0·41
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	410,379	1	0·00	1,391	3·39	424	1·03	61	0·15	21	0·05	259	0·63
AGGREGATE OF RURAL DISTRICTS.	181,361	–	–	625	3·45	246	1·36	25	0·14	7	0·04	66	0·36
BOROUGHS AND URBAN DISTRICTS:—													
Alderley Edge	2,985	–	–	4	1·34	1	0·34	–	–	–	–	1	0·34
Alsager	2,716	–	–	2	0·74	6	2·21	2	0·74	–	–	3	1·10
Altrincham	17,731	–	–	28	1·58	10	0·56	1	0·06	1	0·06	10	0·56
Ashton upon Mersey ..	7,483	–	–	20	2·67	18	2·41	–	–	–	–	5	0·67
Bollington	5,001	–	–	38	7·60	2	0·40	1	0·20	–	–	–	–
Bowdon	2,872	–	–	3	1·04	1	0·35	–	–	–	–	1	0·35
Bredbury and Romiley ..	9,163	–	–	75	8·19	8	0·87	–	–	–	–	10	1·09

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Chester—*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Bromborough	2,178	–	–	18	8·26	–	–	–	–	1	0·46	3	1·38
Buglawton	1,460	–	–	11	7·53	1	0·68	–	–	–	–	–	–
Cheadle and Gatley ..	10,417	–	–	25	2·40	10	0·96	–	–	–	–	12	1·15
Compstall	900	–	–	1	1·11	–	–	–	–	–	–	1	1·11
Congleton	10,918	–	–	43	3·94	7	0·64	–	–	1	0·09	8	0·73
Crewe..	45,825	1	0·02	184	4·02	73	1·59	3	0·07	2	0·04	24	0·52
Dukinfield	18,590	–	–	34	1·83	4	0·22	7	0·38	1	0·05	19	1·02
Ellesmere Port and Whitby.	10,701	–	–	51	5·05	8	0·75	–	–	–	–	5	0·47
Hale	8,914	–	–	36	4·04	2	0·22	–	–	–	–	1	0·11
Handforth	956	–	–	1	1·05	1	1·05	1	1·05	–	–	–	–
Hazel Grove and Bramhall.	10,002	–	–	13	1·30	2	0·20	–	–	–	–	1	0·10
Higher Bebington ..	1,628	–	–	1	0·61	–	–	–	–	–	–	1	0·61
Hollingworth	2,521	–	–	1	0·40	2	0·79	–	–	–	–	1	0·40
Hoole	5,619	–	–	9	1·60	6	1·07	2	0·36	–	–	9	1·60
*Hoylake and West Kirby	13,671	–	–	38	2·78	10	0·73	–	–	–	–	5	0·37
Hyde	32,665	–	–	115	3·52	12	0·37	4	0·12	5	0·15	50	1·53
Knutsford	4,964	–	–	9	1·81	4	0·81	1	0·20	–	–	3	0·60
Lower Bebington	13,118	–	–	30	2·29	29	2·21	3	0·23	–	–	12	0·91
Lymm	5,028	–	–	24	4·77	33	6·56	–	–	–	–	2	0·40
Macclesfield..	32,199	–	–	65	2·02	19	0·59	7	0·22	3	0·09	15	0·47
Marple	6,298	–	–	29	4·60	–	–	–	–	–	–	2	0·32
Middlewich	4,860	–	–	1	0·21	2	0·41	1	0·21	–	–	1	0·21
Mottram in Longdendale	2,988	–	–	1	0·33	–	–	–	–	–	–	–	–
Nantwich	7,136	–	–	25	3·50	23	3·22	1	0·14	–	–	6	0·84
Neston and Parkgate ..	4,570	–	–	3	0·66	2	0·44	–	–	–	–	–	–
Northwich	18,027	–	–	24	1·33	16	0·89	–	–	3	0·17	7	0·39
Runcorn	17,676	–	–	250	14·14	14	0·79	7	0·40	1	0·06	19	1·07
Sale	15,486	–	–	53	3·42	35	2·26	2	0·13	–	–	2	0·13
Sandbach	5,784	–	–	12	2·07	3	0·52	–	–	1	0·17	–	–
Stalybridge	24,511	–	–	75	3·06	7	0·29	8	0·33	1	0·04	14	0·57
Tarporley	2,402	–	–	16	6·66	–	–	–	–	–	–	–	–
Wilmslow	8,131	–	–	5	0·61	3	0·37	3	0·37	–	–	–	–
Winsford	10,664	–	–	14	1·31	47	4·41	7	0·66	1	0·09	6	0·56
Yeardsley cum Whaley ..	1,621	–	–	1	0·62	3	1·85	–	–	–	–	–	–
RURAL DISTRICTS :—													
Bucklow	21,883	–	–	68	3·11	33	1·51	2	0·09	2	0·09	17	0·78
Chester	11,091	–	–	37	3·34	14	1·26	4	0·36	–	–	1	0·09
Congleton	12,840	–	–	31	2·41	16	1·25	–	–	1	0·08	6	0·47
Disley	2,972	–	–	9	3·03	–	–	1	0·34	–	–	3	1·01
Macclesfield..	16,680	–	–	31	1·86	17	1·02	2	0·12	2	0·12	6	0·36
Malpas	4,330	–	–	11	2·54	7	1·62	–	–	–	–	–	–
Nantwich	24,572	–	–	67	2·73	26	1·06	–	–	–	–	7	0·29
Northwich	23,435	–	–	102	4·35	51	2·18	1	0·04	1	0·04	12	0·51
Runcorn	28,405	–	–	199	7·01	51	1·80	6	0·21	1	0·04	10	0·35
Tarvin	12,850	–	–	37	2·88	3	0·23	–	–	–	–	–	–
Tintwistle	2,184	–	–	1	0·46	–	–	1	0·46	–	–	–	–
*Wirral	20,119	–	–	32	1·59	28	1·39	8	0·40	–	–	4	0·20
County of Cornwall.													
ADMINISTRATIVE COUNTY	307,626	–	–	637	2·07	699	2·27	43	0·14	7	0·02	144	0·47
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	132,736	–	–	248	1·87	409	3·08	22	0·17	6	0·05	64	0·48
AGGREGATE OF RURAL DISTRICTS.	174,890	–	–	389	2·22	290	1·66	21	0·12	1	0·01	80	0·46
BOROUGHS AND URBAN DISTRICTS :—													
Bodmin	4,014	–	–	3	0·75	12	2·99	–	–	–	–	6	1·49
Callington	1,663	–	–	–	–	8	4·81	–	–	–	–	–	–
Camborne	15,418	–	–	58	3·76	17	1·10	3	0·19	1	0·06	25	1·62
Falmouth	10,811	–	–	8	0·74	5	0·46	3	0·28	–	–	4	0·37
Fowey	1,893	–	–	–	–	–	–	1	0·53	–	–	2	1·06
Hayle	973	–	–	–	–	1	1·03	–	–	–	–	–	–
Helston	2,603	–	–	–	–	–	–	–	–	–	–	–	–

* On 1st April, 1915, parts of the Urban District of Hoylake and West Kirby were transferred to the Rural District of Wirral, and *vice versâ*. Allowance has been made in the calculation of rates.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Cornwall— *continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Launceston	3,901	-	-	4	1·03	6	1·54	-	-	-	-	4	1·03
Liskeard	4,123	-	-	-	-	5	1·21	-	-	-	-	-	-
Looe	2,605	-	-	5	1·92	2	0·77	1	0·38	-	-	-	-
Lostwithiel	1,250	-	-	2	1·60	1	0·80	2	1·60	-	-	-	-
Ludgvan	2,169	-	-	-	-	-	-	1	0·46	1	0·46	-	-
Madron	3,439	-	-	1	0·29	16	4·65	1	0·29	-	-	1	0·29
Newquay	4,212	-	-	2	0·47	-	-	-	-	2	0·47	1	0·24
Padstow	1,503	-	-	23	15·30	1	0·67	1	0·67	-	-	-	-
Paul	5,534	-	-	1	0·18	19	3·43	-	-	-	-	1	0·18
Penryn	2,917	-	-	6	2·06	-	-	-	-	-	-	2	0·69
Penzance	11,409	-	-	10	0·88	28	2·45	4	0·35	1	0·09	1	0·09
Phillack	3,746	-	-	1	0·27	-	-	-	-	-	-	2	0·53
Redruth	10,474	-	-	58	5·54	158	15·08	-	-	-	-	2	0·19
St. Austell	2,935	-	-	-	-	-	-	-	-	-	-	-	-
St. Ives	6,391	-	-	35	5·48	4	0·63	-	-	-	-	2	0·31
St. Just	5,403	-	-	7	1·30	19	3·52	2	0·37	-	-	5	0·93
Saltash	3,632	-	-	9	2·48	51	14·87	1	0·28	-	-	1	0·28
Stratton and Bude ..	2,755	-	-	2	0·73	-	-	-	-	1	0·36	1	0·36
Torpoint	4,192	-	-	6	1·43	28	6·68	1	0·24	-	-	2	0·48
Truro	10,446	-	-	7	0·67	25	2·39	1	0·10	-	-	1	0·10
Wadebridge..	2,325	-	-	-	-	-	-	-	-	-	-	1	0·43
RURAL DISTRICTS:—													
Bodmin	10,099	-	-	7	0·69	14	1·39	4	0·40	-	-	2	0·20
Calstock	4,683	-	-	68	14·52	4	0·85	1	0·21	-	-	10	2·14
Camelford	7,251	-	-	16	2·21	1	0·14	-	-	-	-	2	0·28
East Kerrier	7,869	-	-	38	4·83	5	0·64	1	0·13	-	-	3	0·38
Helston	16,304	-	-	37	2·27	9	0·55	-	-	-	-	2	0·12
*Holsworthy (part of) ..	312	-	-	-	-	-	-	-	-	-	-	-	-
Launceston	7,246	-	-	21	2·90	9	1·24	-	-	-	-	5	0·69
Liskeard	14,136	-	-	10	0·71	39	2·76	2	0·14	-	-	10	0·71
Redruth	17,201	-	-	76	4·42	64	3·72	-	-	-	-	10	0·58
St. Austell	30,402	-	-	31	1·02	23	0·76	3	0·10	1	0·03	14	0·46
St. Columb Major	11,184	-	-	9	0·80	-	-	-	-	-	-	-	-
St. Germans..	11,478	-	-	14	1·22	82	7·14	5	0·44	-	-	5	0·44
Stratton	4,888	-	-	4	0·82	-	-	-	-	-	-	1	0·20
Truro	19,585	-	-	51	2·60	31	1·58	1	0·05	-	-	12	0·61
West Penwith	10,589	-	-	6	0·57	9	0·85	4	0·38	-	-	4	0·38
Isles of Scilly	1,663	-	-	1	0·60	-	-	-	-	-	-	-	-
County of Cumberland.													
ADMINISTRATIVE COUNTY	204,939	-	-	1151	5·62	215	1·05	15	0·07	5	0·02	144	0·70
COUNTY BOROUGH:— Carlisle	50,036	-	-	561	11·27	68	1·36	2	0·04	1	0·02	72	1·44
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	114,091	-	-	724	6·35	121	1·06	13	0·11	-	-	98	0·86
AGGREGATE OF RURAL DISTRICTS.	90,848	-	-	427	4·70	94	1·03	2	0·02	5	0·06	46	0·51
BOROUGHS AND URBAN DISTRICTS:—													
Arlecdon and Frizington	4,900	-	-	74	15·10	8	1·63	-	-	-	-	5	1·02
Aspatria	3,331	-	-	9	2·70	-	-	-	-	-	-	12	3·60
Cleator Moor	7,991	-	-	84	10·51	2	0·25	-	-	-	-	17	2·13
Cockermouth	4,526	-	-	15	3·31	16	3·54	-	-	-	-	4	0·88
Egremont	6,275	-	-	10	1·59	3	0·48	-	-	-	-	3	0·48
Harrington	3,963	-	-	52	13·12	-	-	1	0·25	-	-	-	-
Holme Cultram	4,436	-	-	49	11·05	1	0·23	1	0·23	-	-	9	2·03
Keswick	4,381	-	-	11	2·51	1	0·23	-	-	-	-	-	-
Maryport	10,320	-	-	112	10·85	6	0·58	-	-	-	-	2	0·19
Millom	9,376	-	-	38	4·05	28	2·99	-	-	-	-	5	0·53
Penrith	8,230	-	-	5	0·61	5	0·61	-	-	-	-	6	0·73
Whitehaven..	18,040	-	-	52	2·88	9	0·50	5	0·28	-	-	15	0·83
Wigton	3,419	-	-	6	1·75	1	0·29	1	0·29	-	-	2	0·58
Workington	24,903	-	-	207	8·31	41	1·65	5	0·20	-	-	18	0·72

* The remaining part of the Rural District of Holsworthy is in the Administrative County of Devonshire.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Cumberland—*continued.*													
RURAL DISTRICTS :—													
Alston with Garrigill ..	2,761	–	–	11	3·98	9	3·26	–	–	–	–	2	0·72
Bootle	5,502	–	–	7	1·27	6	1·09	–	–	–	–	–	–
Brampton	7,717	–	–	10	1·30	5	0·65	2	0·26	–	–	–	–
Carlisle	10,790	–	–	46	4·26	5	0·46	–	–	–	–	9	0·83
Cockermouth	21,379	–	–	234	10·95	33	1·54	–	–	1	0·05	9	0·42
Longtown	5,859	–	–	4	0·68	7	1·19	–	–	1	0·17	1	0·17
Penrith	12,282	–	–	9	0·73	18	1·47	–	–	–	–	–	–
Whitehaven..	13,722	–	–	89	6·49	9	0·66	–	–	3	0·22	10	0·73
Wigton	10,836	–	–	17	1·57	2	0·18	–	–	–	–	15	1·38
County of Derby.													
ADMINISTRATIVE COUNTY	553,990	–	–	2,703	4·88	966	1·74	94	0·17	41	0·07	313	0·56
COUNTY BOROUGH :—													
Derby	119,072	–	–	815	6·84	296	2·49	16	0·13	10	0·08	93	0·78
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	284,948	–	–	1,251	4·39	515	1·81	49	0·17	25	0·09	151	0·54
AGGREGATE OF RURAL DISTRICTS.	269,042	–	–	1,452	5·40	451	1·68	45	0·17	16	0·06	159	0·59
BOROUGHS AND URBAN DISTRICTS :—													
Alfreton	19,431	–	–	123	6·33	41	2·11	3	0·15	3	0·15	9	0·46
Alvaston and Boulton ..	1,529	–	–	3	1·96	1	0·65	–	–	–	–	–	–
Ashbourne	3,888	–	–	3	0·77	–	–	1	0·26	–	–	–	–
Bakewell	2,837	–	–	3	1·06	2	0·70	–	–	–	–	1	0·35
Baslow and Bubnell ..	798	–	–	–	–	11	13·78	–	–	–	–	–	–
Belper	11,756	–	–	22	1·87	43	3·66	4	0·34	1	0·09	8	0·68
Bolsover	11,088	–	–	115	10·37	30	2·71	1	0·09	2	0·18	12	1·08
Bonsall	1,214	–	–	–	–	2	1·65	–	–	–	–	1	0·82
Brampton and Walton ..	2.287	–	–	–	–	2	0·87	–	–	–	–	–	–
Buxton	9,590	–	–	44	4·59	–	–	4	0·42	–	–	5	0·52
Chesterfield	37,653	–	–	126	3·35	80	2·12	7	0·19	3	0·08	21	0·56
Clay Cross	8,108	–	–	22	2·71	7	0·86	–	–	–	–	6	0·74
Dronfield	4,179	–	–	25	5·98	16	3·83	1	0·24	–	–	1	0·24
Fairfield	4,299	–	–	1	0·23	–	–	2	0·47	–	–	–	–
Glossop	20,665	–	–	103	4·98	9	0·44	3	0·15	3	0·15	11	0·53
Heage	3,673	–	–	4	1·09	5	1·36	1	0·27	–	–	2	0·54
Heanor	20,918	–	–	177	8·46	34	1·63	3	0·14	1	0·05	12	0·57
Ilkeston	30,859	–	–	128	4·15	71	2·30	11	0·36	1	0·03	6	0·19
Long Eaton	17,460	–	–	128	7·33	32	1·83	–	–	2	0·11	10	0·57
Matlock	5,950	–	–	5	0·84	7	1·18	–	–	–	–	3	0·50
Matlock Bath and Scarthin Nick	1,593	–	–	–	–	9	5·65	–	–	–	–	–	–
New Mills	8,288	–	–	2	0·24	8	0·97	2	0·24	–	–	8	0·97
North Darley	3,011	–	–	2	0·66	–	–	–	–	–	–	3	1·00
Ripley	12,661	–	–	84	6·63	13	1·03	1	0·08	–	–	5	0·39
South Darley	742	–	–	–	–	–	–	–	–	–	–	–	–
Swadlincote	18,975	–	–	34	1·79	51	2·69	3	0·16	2	0·11	14	0·74
Whittington and Newbold	17,834	–	–	91	5·10	22	1·23	2	0·11	3	0·17	16	0·90
Wirksworth	3,657	–	–	6	1·64	19	5·20	–	–	4	1·09	–	–
RURAL DISTRICTS :—													
Ashbourne	10,318	–	–	18	1·74	1	0·10	4	0·39	–	–	6	0·58
Bakewell	19,380	–	–	26	1·34	19	0·98	11	0·57	–	–	3	0·15
Belper..	25,451	–	–	137	5·38	36	1·41	3	0·12	1	0·04	7	0·28
Blackwell	39,540	–	–	213	5·39	80	2·02	8	0·20	4	0·10	23	0·58
Chapel en le Frith ..	15,383	–	–	93	6·05	11	0·72	7	0·46	–	–	8	0·52
Chesterfield	71,883	–	–	573	7·97	107	1·49	3	0·04	8	0·11	43	0·60
Clowne	17,507	–	–	103	5·88	77	4·40	–	–	–	–	16	0·91
*Codnor Park and Shipley (parishes).	1,440	–	–	5	3·47	3	2·08	–	–	–	–	1	0·69
Glossop Dale	3,801	–	–	5	1·32	1	0·26	2	0·53	–	–	2	0·53
Hartshorn and Seals ..	8,113	–	–	37	4·56	34	4·19	1	0·12	2	0·25	12	1·48
Hayfield	4,054	–	–	3	0·74	6	1·48	–	–	–	–	2	0·49
Norton	4,228	–	–	4	0·95	13	3·07	1	0·24	–	–	3	0·71
Repton	14,453	–	–	88	6·09	16	1·11	–	–	–	–	3	0·21
Shardlow	30,959	–	–	140	4·52	46	1·49	1	0·03	1	0·03	30	0·97
Sudbury	2,527	–	–	7	2·77	1	0·40	4	1·58	–	–	–	–

* These parishes are administered by the Rural District Council of Basford (Notts.).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Devon.													
ADMINISTRATIVE COUNTY	400,985	-	-	1,089	2·72	746	1·86	59	0·15	15	0·04	135	0·34
COUNTY BOROUGHS :—													
Exeter	55,460	-	-	64	1·15	62	1·12	20	0·36	2	0·04	25	0·45
Plymouth	187,911	-	-	380	2·02	350	1·86	81	0·43	9	0·05	194	1·03
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	192,270	-	-	567	2·96	372	1·94	19	0·10	4	0·02	80	0·42
AGGREGATE OF RURAL DISTRICTS.	208,715	-	-	522	2·50	374	1·79	40	0·19	11	0·05	55	0·26
BOROUGHS AND URBAN DISTRICTS :—													
Ashburton	2,227	-	-	-	-	-	-	1	0·45	-	-	1	0·45
Axminster	1,954	-	-	-	-	-	-	-	-	-	-	-	-
Bampton	1,490	-	-	-	-	-	-	-	-	-	-	-	-
Barnstaple	13,479	-	-	20	1·48	52	3·86	-	-	-	-	3	0·22
Bideford	8,403	-	-	45	5·36	22	2·62	-	-	-	-	6	0·71
Brixham	7,738	-	-	-	-	9	1·16	2	0·26	-	-	3	0·39
Buckfastleigh	2,209	-	-	-	-	2	0·91	-	-	-	-	1	0·45
Budleigh Salterton ..	2,325	-	-	1	0·43	-	-	1	0·43	-	-	1	0·43
Crediton	3,305	-	-	11	3·33	3	0·91	1	0·30	-	-	4	1·21
Dartmouth	5,457	-	-	8	1·47	13	2·38	2	0·37	-	-	3	0·55
Dawlish	3,729	-	-	5	1·34	-	-	-	-	-	-	-	-
Exmouth	12,022	-	-	16	1·33	1	0·08	2	0·17	-	-	10	0·83
Great Torrington	2,828	-	-	110	38·90	15	5·30	-	-	-	-	5	1·77
Holsworthy	1,378	-	-	-	-	12	8·71	-	-	-	-	-	-
Honiton	2,904	-	-	-	-	4	1·38	-	-	-	-	3	1·03
Ilfracombe	8,517	-	-	4	0·47	6	0·70	-	-	-	-	1	0·12
Ivybridge	1,587	-	-	-	-	-	-	-	-	-	-	-	-
Kingsbridge	2,910	-	-	8	2·75	-	-	-	-	-	-	2	0·69
Lynton	1,726	-	-	1	0·58	3	1·74	1	0·58	-	-	3	1·74
Newton Abbot	12,939	-	-	100	7·73	29	2·24	2	0·15	-	-	6	0·46
Northam	5,362	-	-	8	1·49	5	0·93	-	-	-	-	-	-
Okehampton	3,045	-	-	21	6·90	2	0·66	-	-	-	-	1	0·33
Ottery St. Mary	3,445	-	-	19	5·52	11	3·19	-	-	-	-	3	0·87
Paignton	11,880	-	-	64	5·39	5	0·42	-	-	-	-	1	0·08
Salcombe	1,920	-	-	3	1·56	-	-	1	0·52	-	-	2	1·04
Seaton	1,734	-	-	1	0·58	1	0·58	-	-	-	-	2	1·15
Sidmouth	4,637	-	-	12	2·59	68	14·66	-	-	-	-	2	0·43
South Molton	2,574	-	-	2	0·78	1	0·39	-	-	-	-	1	0·39
Tavistock	4,209	-	-	3	0·71	-	-	1	0·24	-	-	2	0·48
Teignmouth	8,919	-	-	33	3·70	4	0·45	3	0·34	3	0·34	4	0·45
Tiverton	9,077	-	-	29	3·19	3	0·33	1	0·11	-	-	7	0·77
Torquay	32,520	-	-	42	1·29	98	3·01	1	0·03	1	0·03	2	0·06
Totnes	3,821	-	-	1	0·26	3	0·79	-	-	-	-	1	0·26
RURAL DISTRICTS :—													
*Axminster	9,691	-	-	30	2·95	3	0·30	-	-	1	0·10	4	0·39
Barnstaple	17,629	-	-	17	0·96	37	2·10	-	-	-	-	3	0·17
Bideford	6,103	-	-	30	4·92	4	0·66	1	0·16	2	0·33	1	0·16
Broadwoodwidger ..	2,260	-	-	4	1·77	1	0·44	-	-	-	-	1	0·44
Crediton	10,044	-	-	27	2·69	12	1·19	5	0·50	2	0·20	1	0·10
Culmstock	3,214	-	-	4	1·24	5	1·56	1	0·31	-	-	1	0·31
†Holsworthy (part of) ..	6,772	-	-	8	1·18	4	0·59	-	-	-	-	2	0·30
Honiton	9,105	-	-	14	1·54	41	4·50	1	0·11	-	-	1	0·11
Kingsbridge	11,132	-	-	18	1·62	2	0·18	4	0·36	-	-	1	0·09
Newton Abbot	18,782	-	-	121	6·44	55	2·93	1	0·05	1	0·05	7	0·37
Okehampton	12,867	-	-	20	1·55	24	1·87	1	0·08	1	0·08	8	0·62
Plympton St. Mary ..	19,173	-	-	55	2·87	69	3·60	11	0·57	1	0·05	5	0·26
St. Thomas	23,467	-	-	90	3·84	68	2·90	13	0·55	3	0·13	8	0·34
South Molton	10,181	-	-	17	1·67	5	0·49	-	-	-	-	1	0·10
Tavistock	14,358	-	-	16	1·11	16	1·11	-	-	-	-	3	0·21
Tiverton	14,382	-	-	36	2·50	5	0·35	1	0·07	-	-	5	0·35
Torrington	8,396	-	-	9	1·07	14	1·67	1	0·12	-	-	3	0·36
Totnes	11,159	-	-	6	0·54	9	0·81	-	-	-	-	-	-

* On 1st April, 1915, the Urban District of Axminster was constituted out of part of the Rural District of Axminster. Allowance has been made in the calculation of rates.

† The remaining part of the Rural District of Holsworthy is in the Administrative County of Cornwall. The figures for the entire District are :—

7,084	-	-	8	1·13	4	0·56	-	-	-	-	2	0·28

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases	Rate.
County of Dorset.													
ADMINISTRATIVE COUNTY	206,982	–	–	399	1·93	177	0·86	19	0·09	12	0·06	72	0·35
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	108,357	–	–	186	1·72	116	1·07	16	0·15	7	0·06	41	0·38
AGGREGATE OF RURAL DISTRICTS.	98,625	–	–	213	2·16	61	0·62	3	0·03	5	0·05	31	0·31
BOROUGHS AND URBAN DISTRICTS :—													
Blandford Forum ..	3,349	–	–	21	6·27	5	1·49	1	0·30	–	–	–	–
Bridport	5,557	–	–	15	2·70	12	2·16	2	0·36	–	–	1	0·18
Dorchester	8,873	–	–	11	1·24	20	2·25	–	–	–	–	3	0·34
Lyme Regis	2,238	–	–	5	2·23	18	8 04	–	–	–	–	5	2·23
Poole	39,461	–	–	77	1·95	33	0·84	6	0·15	3	0·08	19	0·48
Portland	9,159	–	–	3	0·33	2	0·22	–	–	–	–	4	0·44
Shaftesbury..	1,761	–	–	17	9·65	10	5·68	–	–	–	–	1	0·57
Sherborne	5,514	–	–	8	1·45	5	0·91	–	–	–	–	–	–
Swanage	4,643	–	–	5	1·08	–	–	1	0·22	–	–	1	0·22
Wareham	2,100	–	–	7	3·33	–	–	1	0·48	–	–	1	0·48
Weymouth and Melcombe Regis.	22,224	–	–	12	0·54	6	0·27	5	0·22	3	0·13	5	0·22
Wimborne Minster ..	3,478	–	–	5	1·44	5	1·44	–	–	1	0·29	1	0·29
RURAL DISTRICTS :—													
Beaminster	8,389	–	–	12	1·43	1	0·12	–	–	–	–	–	–
*Blandford	8,195	–	–	35	4·27	2	0·24	–	–	–	–	1	0·12
Bridport	6,408	–	–	16	2·50	1	0·16	–	–	1	0·16	1	0·16
Cerne	4,437	–	–	13	2·93	–	–	–	–	–	–	3	0·68
Dorchester	7,824	–	–	4	0·51	8	1·02	–	–	–	–	3	0·38
Poole	6,995	–	–	9	1·29	4	0·57	–	–	1	0·14	2	0·29
*Shaftesbury..	9,859	–	–	20	2·03	14	1·42	–	–	–	–	5	0·51
Sherborne	5,324	–	–	5	0·94	5	0·94	–	–	–	–	1	0·19
Sturminster	7,448	–	–	20	2·69	6	0·81	–	–	–	–	5	0·67
Wareham and Purbeck ..	10,506	–	–	21	2·00	8	0·76	1	0·10	–	–	–	–
Weymouth	8,822	–	–	19	2·15	5	0·57	1	0·11	–	–	1	0·11
Wimborne and Cranborne	14,418	–	–	39	2·70	7	0·49	1	0·07	3	0·21	9	0·62
County of Durham.													
ADMINISTRATIVE COUNTY	855,245	–	–	4117	4·81	1599	1·87	249	0·29	38	0·04	582	0·68
COUNTY BOROUGHS :—													
†Darlington	60,268	–	–	162	2·71	135	2·26	7	0·12	2	0·03	44	0·74
Gateshead	120,830	–	–	446	3·69	81	0·67	24	0·20	5	0·04	95	0·79
South Shields	109,855	–	–	922	8·39	34	0·31	9	0·08	4	0·04	58	0·53
Sunderland	148,273	–	–	254	1·71	108	0·73	15	0·10	10	0·07	95	0·64
West Hartlepool	63,463	–	–	77	1·21	40	0·63	11	0·17	1	0·02	36	0·57
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	464,380	–	–	2053	4·42	824	1·77	139	0·30	17	0·04	313	0·67
AGGREGATE OF RURAL DISTRICTS.	390,865	–	–	2064	5·27	775	1·98	110	0·28	21	0·05	269	0·69
BOROUGHS AND URBAN DISTRICTS :—													
Annfield Plain	15,889	–	–	24	1·51	32	2·01	4	0·25	–	–	10	0·63
Barnard Castle	4,206	–	–	11	2·62	16	3·80	–	–	–	–	5	1·19
Benfieldside	7,568	–	–	125	16·52	107	14·14	7	0·92	–	–	13	1·72
Bishop Auckland	12,825	–	–	44	3·43	6	0·47	10	0·78	–	–	4	0·31
Blaydon	30,699	–	–	149	4·85	63	2·05	6	0·20	2	0·07	17	0·55
Brandon and Byshottles	16,902	–	–	33	1·95	21	1·24	9	0·53	1	0·06	11	0·65
Chester le Street	14,091	–	–	48	3·41	11	0·78	22	1·56	–	–	11	0·78
Consett	10,688	–	–	138	12·91	53	4·96	–	–	–	–	5	0·47
Crook	11,823	–	–	83	7·02	65	5·50	3	0·25	1	0·08	11	0·93
Durham	14,712	–	–	28	1·90	15	1·02	3	0·20	2	0·14	7	0·48
Felling	24,697	–	–	100	4·05	2	0·08	3	0·12	1	0 04	17	0·69
Hartlepool	18,819	–	–	35	1·86	12	0·64	2	0·11	–	–	19	1·01
‡Hebburn	22,805	–	–	108	4·74	13	0·57	8	0·35	–	–	24	1·05
Hetton	15,477	–	–	39	2·52	29	1·87	8	0·52	–	–	26	1·68
Houghton le Spring ..	8,979	–	–	52	5·79	21	2·34	5	0·56	–	–	6	0·67
Jarrow	35,394	–	–	114	3·22	40	1·13	5	0·14	–	–	18	0·51
Leadgate	4,791	–	–	48	10·02	10	2·09	–	–	–	–	5	1·04
Ryton	11,286	–	–	76	6·73	49	4·34	8	0·71	1	0·09	8	0·71
Seaham Harbour	15,857	–	–	22	1·39	6	0·38	1	0·06	–	–	4	0·25

* On 1st April, 1915, the Rural District of Blandford was extended to include parts of the Rural District of Shaftesbury. The area transferred contained no population at the Census of 1911.

† On 1st April, 1915, part of the Rural District of Darlington was transferred to the Borough of Darlington, and *vice versâ*. Darlington M.B., thus altered, was constituted a County Borough. Allowance has been made in the calculation of rates.

‡ One case of Typhus Fever was notified

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Durham—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Shildon and East Thickley.	12,974	–	–	35	2·70	19	1·46	8	0·62	–	–	7	0·54
Southwick on Wear ..	13,634	–	–	37	2·71	8	0·59	3	0·22	–	–	2	0·15
Spennymoor	16,785	–	–	152	9·06	10	0·60	3	0·18	1	0·06	4	0·24
Stanhope	1,792	–	–	4	2·23	19	10·60	–	–	–	–	1	0·56
Stanley	22,989	–	–	162	7·05	35	1·52	–	–	–	–	4	0·17
Stockton on Tees	57,882	–	–	187	3·23	91	1·57	13	0·22	4	0·07	34	0·59
Tanfield	9,673	–	-	49	5·07	23	2·38	2	0·21	1	0·10	24	2·48
Tow Law	3,449	–	–	70	20·30	3	0·87	2	0·58	–	–	1	0·29
Whickham	18,898	–	–	69	3·65	26	1·90	2	0·11	3	0·16	12	0·63
Willington	8,796	–	–	11	1·25	9	1·02	2	0·23	–	–	3	0·34
RURAL DISTRICTS:—													
Auckland	57,614	–	–	390	6·77	89	1·54	33	0·57	7	0·12	27	0·47
Barnard Castle	11 378	–	–	63	5·54	2	0·18	1	0·09	1	0·09	3	0·26
Chester le Street	63,555	–	–	445	7·00	155	2·44	9	0·14	5	0·08	47	0·74
*Darlington	9,105	–	–	20	2·10	13	1·36	3	0·31	–	–	14	1·47
Durham	29,238	–	–	222	7·59	50	1·71	7	0·24	–	–	16	0·55
Easington	66,471	–	–	191	2·87	54	0·81	17	0·26	3	0·05	59	0·89
Hartlepool	2,735	–	–	4	1·46	1	0·37	4	1·46	–	–	–	–
Houghton le Spring ..	25,081	–	–	84	3·35	42	1·67	8	0·32	1	0·04	25	1·00
Lanchester	30,630	–	–	188	6·14	156	5·09	7	0·23	–	–	24	0·78
Sedgefield	32,398	–	–	215	6·64	71	2·19	3	0·09	1	0·03	13	0·40
South Shields	15,456	–	–	52	3·36	12	0·78	4	0·26	1	0·06	7	0·45
Stockton	11,091	–	–	29	2·61	39	3·52	4	0·36	–	–	6	0·54
Sunderland	27,161	–	–	90	3·31	60	2·21	10	0·37	2	0·07	19	0·70
Weardale	8,922	–	–	71	7·96	31	3·47	–	–	–	–	9	1·01
County of Essex.													
ADMINISTRATIVE COUNTY	860,695	1	0·00	2,911	3·38	1,212	1·41	97	0·11	24	0·03	488	0·57
COUNTY BOROUGHS:—													
East Ham	142,582	–	–	496	3·48	207	1·45	5	0·04	4	0·03	96	0·67
Southend on Sea	76,382	–	–	159	2·08	70	0·92	7	0·09	7	0·09	29	0·38
West Ham	294,396	–	–	733	2·49	476	1·62	54	0·18	8	0·03	228	0·77
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	608,752	1	0·00	2,044	3·36	926	1·52	68	0·11	20	0·03	387	0·64
AGGREGATE OF RURAL DISTRICTS.	251,943	–	–	867	3·44	286	1·14	29	0·12	4	0·02	101	0·40
BOROUGHS AND URBAN DISTRICTS:—													
Barking Town	34,479	–	–	138	4·00	74	2·15	5	0·15	–	–	48	1·39
Braintree	6,375	–	–	23	3·61	11	1·73	1	0·16	1	0·16	1	0·16
Brentwood	6,255	–	–	3	0·48	21	3·36	–	–	–	–	3	0·48
Brightlingsea	4,370	–	–	9	2·06	–	–	4	0·92	–	–	3	0·69
Buckhurst Hill	4,770	–	–	2	0·42	2	0·42	–	–	–	–	–	–
Burnham on Crouch ..	3,183	–	–	–	–	–	–	–	–	–	–	–	–
Chelmsford	19,833	–	–	43	2·17	32	1·61	–	–	3	0·15	7	0·35
Chingford	9,078	–	–	32	3·52	8	0·88	5	0·55	–	-	3	0·33
Clacton	9,127	–	–	10	1·10	1	0·11	–	–	–	–	2	0·22
Colchester	38,699	–	–	274	7·08	43	1·11	10	0·26	1	0·03	43	1·11
Epping	4,120	–	–	5	1·21	2	0·49	–	–	1	0·24	1	0·24
Frinton on Sea	1,614	–	–	11	6·82	–	–	1	0·62	–	–	2	1·24
Grays Thurrock	16,083	1	0·06	45	2·80	24	1·49	2	0·12	2	0·12	1	0·06
Halstead	5,891	–	–	109	18·50	3	0·51	–	–	–	–	–	–
Harwich	11,984	–	–	37	3·09	10	0·83	4	0·33	–	–	4	0·33
Ilford	80,832	–	–	223	2·76	124	1·53	4	0·05	-	–	45	0·56
Leyton	124,497	–	–	465	3·74	168	1·35	8	0·06	6	0·05	79	0·63
Loughton	5,642	–	–	–	–	5	0·89	–	–	–	–	4	0·71
Maldon	5,736	–	–	46	8·02	3	0·52	–	–	–	–	1	0·17
Romford	17,985	–	–	55	3·06	60	3·34	3	0·17	1	0·06	19	1·06
Saffron Walden	5,544	–	–	12	2·16	–	–	–	–	–	–	5	0·90
Shoeburyness	4,590	–	–	7	1·53	4	0·87	1	0·22	1	0·22	6	1·31
Tilbury	6,330	–	–	31	4·90	14	2·21	-	–	1	0·16	8	1·26
Waltham Holy Cross ..	7,294	–	–	9	1·23	2	0·27	–	–	–	–	4	0·55
Walthamstow	131,718	–	–	316	2·40	266	2·02	11	0·08	3	0·02	73	0·55

* On 1st April, 1915, part of the Rural District of Darlington was transferred to the Borough of Darlington, and *vice versâ*. Darlington M.B., thus altered, was constituted a County Borough. Allowance has been made in the calculation of rates.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Essex—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Walton on the Naze ..	2,030	–	–	49	24·14	–	–	–	–	–	–	2	0·99
Wanstead	15,635	–	–	15	0·96	14	0·90	1	0·06	–	–	5	0·32
Witham	3,327	–	–	1	0·30	11	3·31	6	1·80	–	–	8	2·40
Wivenhoe	2,303	–	–	6	2·61	13	5·64	1	0·43	–	–	–	–
Woodford	19,428	–	–	68	3·50	11	0·57	1	0·05	–	–	10	0·51
RURAL DISTRICTS:—													
Belchamp	4,252	–	–	1	0·24	–	–	–	–	–	–	1	0·24
Billericay	19,221	–	–	65	3·38	29	1·51	1	0·05	–	–	8	0·42
Braintree	17,764	–	–	68	3·83	22	1·24	1	0·06	–	–	7	0·39
Bumpstead	2,338	–	–	2	0·86	2	0·86	–	–	–	–	–	–
Chelmsford	22,661	–	–	50	2·21	25	1·10	–	–	–	–	9	0·40
Dunmow	14,944	–	–	41	2·74	23	1·54	–	–	–	–	8	0·54
Epping	13,828	–	–	54	3·91	7	0·51	1	0·07	–	–	4	0·29
Halstead	9,644	–	–	19	1·97	3	0·31	7	0·73	–	–	2	0·21
Lexden and Winstree ..	18,946	–	–	82	4·33	18	0·95	2	0·11	1	0·05	1	0·05
Maldon	15,339	–	–	105	6·85	11	0·72	2	0·13	1	0·07	5	0·33
Ongar	10,047	–	–	24	2·39	12	1·19	–	–	–	–	7	0·70
Orsett	19,948	–	–	149	7·47	31	1·55	5	0·25	1	0·05	2	0·10
Rochford	19,015	–	–	48	2·52	4	0·21	2	0·11	1	0·05	16	0·84
Romford	26,692	–	–	85	3·18	41	1·54	1	0·04	–	–	21	0·79
Saffron Walden	10,139	–	–	23	2·27	21	2·07	–	–	–	–	2	0·20
Stansted	6,956	–	–	9	1·29	26	3·74	–	–	–	–	–	–
Tendring	20,209	–	–	42	2·08	11	0·54	7	0·35	–	–	8	0·40
County of Gloucester.													
ADMINISTRATIVE COUNTY	311,767	–	–	1165	3·74	519	1·67	32	0·10	6	0·02	160	0·51
COUNTY BOROUGHS:—													
Bristol	352,859	–	–	1071	3·04	502	1·42	45	0·13	28	0·08	260	0·74
Gloucester	48,139	–	–	96	1·99	104	2·16	1	0·02	2	0·04	35	0·73
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	92,049	–	–	356	3·87	131	1·42	14	0·15	3	0·03	58	0·63
AGGREGATE OF RURAL DISTRICTS.	219,718	–	–	809	3·68	388	1·77	18	0·08	3	0·01	102	0·46
BOROUGHS AND URBAN DISTRICTS:—													
Awre	1,055	–	–	2	1·90	1	0·95	–	–	–	–	–	–
Charlton Kings	4,329	–	–	8	1·85	7	1·62	–	–	–	–	3	0·69
Cheltenham	43,266	–	–	211	4·88	55	1·27	7	0·16	3	0·07	46	1·06
Cirencester	6,940	–	–	39	5·62	11	1·59	1	0·14	–	–	4	0·58
Coleford	2,577	–	–	30	11·64	6	2·33	5	1·94	–	–	–	–
Kingswood	12,993	–	–	16	1·23	7	0·54	–	–	–	–	1	0·08
Nailsworth	2,922	–	–	7	2·40	–	–	–	–	–	–	1	0·34
Newnham	1,024	–	–	–	–	1	0·98	–	–	–	–	–	–
Stow on the Wold ..	1,127	–	–	2	1·77	7	6·21	–	–	–	–	–	–
Stroud	7,929	–	–	33	4·16	35	4·41	–	–	–	–	2	0·25
Tetbury	1,535	–	–	6	3·91	1	0·65	–	–	–	–	1	0·65
Tewkesbury	4,717	–	–	2	0·42	–	–	1	0·21	–	–	–	–
Westbury on Severn ..	1,635	–	–	–	–	–	–	–	–	–	–	–	–
RURAL DISTRICTS:—													
Campden	5,101	–	–	4	0·78	–	–	–	–	–	–	4	0·78
Cheltenham..	5,157	–	–	23	4·46	12	2·33	–	–	–	–	3	0·58
Chipping Sodbury ..	19,905	–	–	57	2·86	32	1·61	–	–	–	–	19	0·95
Cirencester	11,637	–	–	24	2·06	14	1·20	–	–	–	–	5	0·43
Dursley	12,020	–	–	28	2·33	5	0·42	–	–	–	–	11	0·92
East Dean and United Parishes.	19,918	–	–	52	2·61	67	3·36	2	0·10	1	0·05	6	0·30
*Faringdon (part of) ..	1,053	–	–	–	–	–	–	–	–	–	–	–	–
Gloucester	10,847	–	–	10	0·92	16	1·48	7	0·65	–	–	5	0·46
Lydney	9,071	–	–	63	6·95	20	2·20	–	–	–	–	7	0·77
Marston Sicca	1,676	–	–	31	18·50	–	–	–	–	–	–	–	–
Newent	6,704	–	–	5	0·75	13	1·94	–	–	–	–	1	0·15
Northleach	7,610	–	–	29	3·81	20	2·63	–	–	1	0·13	2	0·26
Pebworth	3,160	–	–	7	2·22	–	–	–	–	–	–	3	0·95

* The remaining part of the Rural District of Faringdon is in the Administrative County of Berkshire.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Gloucester —*continued.*													
RURAL DISTRICTS:—													
*Stow on the Wold (part of)	6,259	–	–	5	0·80	15	2·40	–	–	–	–	6	0·96
Stroud	27,186	–	–	160	5·89	58	2·13	2	0·07	–	–	4	0·15
*Tetbury (part of)	3,467	–	–	6	1·73	1	0·29	1	0·29	–	–	–	–
*Tewkesbury (part of) ..	4,663	–	–	7	1·50	–	–	2	0·43	–	–	2	0·43
Thornbury	17,711	–	–	59	3·33	48	2·71	2	0·11	1	0·06	12	0·68
Warmley	17,507	–	–	34	1·94	15	0·86	2	0·11	–	–	8	0·46
West Dean	14,219	–	–	159	11·18	43	3·02	–	–	–	–	1	0·07
Wheatenhurst	5,924	–	–	26	4·39	4	0·68	–	–	–	–	–	–
*Winchcomb (part of) ..	8,923	–	–	20	2·24	5	0·56	–	–	–	–	3	0·34
County of Hereford.													
ADMINISTRATIVE COUNTY	106,879	–	–	337	3·15	118	1·10	11	0·10	3	0·03	82	0·77
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	36,834	–	–	105	2·85	52	1·41	5	0·14	1	0·03	46	1·25
AGGREGATE OF RURAL DISTRICTS.	70,045	–	–	232	3·31	66	0·94	6	0·09	2	0·03	36	0·51
BOROUGHS AND URBAN DISTRICTS:—													
Bromyard	1,565	–	–	–	–	3	1·92	–	–	–	–	2	1·28
Hereford	21,219	–	–	59	2·78	19	0·90	3	0·14	–	–	34	1·60
Kington	1,562	–	–	13	8·32	4	2·56	–	–	–	–	1	0·64
Ledbury	2,934	–	–	3	1·02	4	1·36	1	0·34	–	–	1	0·34
Leominster	5,269	–	–	20	3·80	16	3·04	1	0·19	1	0·19	4	0·76
Ross	4,285	–	–	10	2·33	6	1·40	–	–	–	–	4	0·93
RURAL DISTRICTS:—													
Bredwardine	1,856	–	–	13	7·00	–	–	–	–	–	–	–	–
Bromyard	7,504	–	–	11	1·47	1	0·13	1	0·13	–	–	1	0·13
Dore	6,028	–	–	4	0·66	1	0·17	–	–	–	–	9	1·49
Hereford	12,092	–	–	43	3·56	18	1·49	–	–	1	0·08	4	0·33
Kington	4,666	–	–	13	2·79	2	0·43	–	–	–	–	3	0·64
Ledbury	8,618	–	–	25	2·90	2	0·23	–	–	–	–	4	0·46
Leominster	7,565	–	–	24	3·17	9	1·19	4	0·53	–	–	5	0·66
Ross	10,138	–	–	71	7·00	10	0·99	1	0·10	1	0·10	6	0·59
Weobley	6,377	–	–	24	3·76	21	3·29	–	–	–	–	2	0·31
Whitchurch..	1,535	–	–	1	0·65	–	–	–	–	–	–	–	–
Wigmore	3,666	–	–	3	0·82	2	0·55	–	–	–	–	2	0·55
County of Hertford.													
ADMINISTRATIVE COUNTY	305,122	–	–	681	2·23	480	1·57	18	0·06	16	0·05	142	0·47
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	202,953	–	–	408	2·01	321	1·58	11	0·05	14	0·07	86	0·42
AGGREGATE OF RURAL DISTRICTS.	102,169	–	–	273	2·67	159	1·56	7	0·07	2	0·02	56	0·55
BOROUGHS AND URBAN DISTRICTS:—													
Baldock	2,285	–	–	7	3·06	–	–	–	–	–	–	1	0·44
Barnet	11,359	–	–	25	2·20	–	–	1	0·09	1	0·09	6	0·53
Bishop Stortford .. .	8,158	–	–	5	0·61	45	5·52	–	–	–	–	2	0·25
Bushey	6,964	–	–	7	1·01	3	0·43	–	–	–	–	2	0·29
Cheshunt	14,013	–	–	4	0·29	13	0·93	2	0·14	1	0·07	6	0·43
Chorleywood	2,140	–	–	2	0·93	–	–	–	–	–	–	–	–
East Barnet Valley ..	12,595	–	–	27	2·14	11	0·87	1	0·08	–	–	3	0·24
Great Berkhampstead ..	7,084	–	–	3	0·42	28	3·95	–	–	–	–	1	0·14
Harpenden	6,255	–	–	2	0·32	11	1·76	1	0·16	1	0·16	–	–
Hemel Hempstead ..	12,403	–	–	24	1·94	62	5·00	–	–	1	0·08	7	0·56
Hertford	9,583	–	–	26	2·71	14	1·46	–	–	–	–	8	0·83
Hitchen	11,471	–	–	11	0·96	4	0·35	–	–	1	0·09	3	0·26
Hoddesdon	5,073	–	–	7	1·38	25	4·93	–	–	2	0·39	6	1·18
Rickmansworth	6,944	–	–	42	6·05	4	0·58	1	0·14	1	0·14	3	0·43
Royston	3,706	–	–	2	0·54	–	–	–	–	–	–	–	–
St. Albans	24,393	–	–	96	3·94	15	0·61	–	–	2	0·08	12	0·49

* The remaining parts of the Rural Districts of Stow on the Wold, Tewkesbury and Winchcomb are in the Administrative County of Worcester, and the remaining part of the Rural District of Tetbury is in the Administrative County of Wiltshire. The figures for the entire Districts are:—

Stow on the Wold	6,547	–	–	5	0·76	15	2·29	–	–	–	–	6	0·92
Tetbury	3,797	–	–	6	1·58	2	0·53	1	0·26	–	–	–	–
Tewkesbury	6,788	–	–	8	1·18	5	0·74	2	0·29	–	–	3	0·44
Winchcomb	9,031	–	–	20	2·21	5	0·55	–	–	–	–	–	–

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Hertford—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Sawbridgeworth	2,224	-	-	13	5·85	4	1·80	-	-	-	-	1	0·45
Stevenage	4,930	-	-	1	0·20	-	-	-	-	-	-	1	0·20
Tring	4,202	-	-	5	1·19	1	0·24	2	0·48	-	-	4	0·95
Ware	5,531	-	-	1	0·18	6	1·08	-	-	-	-	2	0·36
Watford	41,640	-	-	98	2·35	75	1·80	3	0·07	4	0·10	18	0·43
RURAL DISTRICTS:—													
Ashwell	3,897	-	-	4	1·03	1	0·26	-	-	-	-	1	0·26
Barnet	4,143	-	-	3	0·72	1	0·24	-	-	-	-	2	0·48
Berkhampstead	4,479	-	-	9	2·01	4	0·89	-	-	1	0·22	2	0·45
Buntingford..	4,690	-	-	3	0·64	11	2·35	1	0·21	-	-	-	-
Hadham	5,486	-	-	42	7·66	6	1·09	-	-	-	-	2	0·36
Hatfield	8,242	-	-	36	4·37	15	1·82	-	-	-	-	1	0·12
Hemel Hempstead ..	6,486	-	-	7	1·08	40	6·17	-	-	1	0·15	3	0·46
Hertford	7,423	-	-	15	2·02	3	0·40	-	-	-	-	3	0·40
Hitchin	21,580	-	-	74	3·43	14	0·65	1	0·05	-	-	9	0·42
St. Albans	10,444	-	-	43	4·12	14	1·34	4	0·38	-	-	4	0·38
Ware	10,240	-	-	23	2·25	21	2·05	-	-	-	-	-	-
Watford	12,614	-	-	12	0·95	28	2·22	1	0·08	-	-	29	2·30
Welwyn	2,445	-	-	2	0·82	1	0·41	-	-	-	-	-	-
County of Huntingdon.													
ADMINISTRATIVE COUNTY	53,246	-	-	97	1·82	18	0·34	1	0·02	4	0·08	15	0·28
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	22,949	-	-	53	2·31	9	0·39	1	0·04	1	0·04	7	0·31
AGGREGATE OF RURAL DISTRICTS.	30,297	-	-	44	1·45	9	0·30	-	-	3	0·10	8	0·26
BOROUGHS AND URBAN DISTRICTS:—													
Godmanchester	1,960	-	-	4	2·04	4	2·04	-	-	-	-	-	-
Huntingdon	3,856	-	-	6	1·56	-	-	-	-	-	-	2	0·52
Old Fletton	5,101	-	-	26	5·10	3	0·59	-	-	1	0·20	1	0·20
Ramsey	5,264	-	-	10	1·90	-	-	1	0·19	-	-	2	0·38
St. Ives	2,782	-	-	1	0·36	-	-	-	-	-	-	1	0·36
St. Neots	3,986	-	-	6	1·51	2	0·50	-	-	-	-	1	0·25
RURAL DISTRICTS:—													
Huntingdon	6,512	-	-	6	0·92	1	0·15	-	-	-	-	4	0·61
Norman Cross	5,336	-	-	25	4·69	2	0·37	-	-	1	0·19	1	0·19
*Oundle (part of)	1,070	-	-	-	-	-	-	-	-	-	-	1	0·93
St. Ives	9,246	-	-	2	0·22	4	0·43	-	-	-	-	-	-
St. Neots	6,872	-	-	11	1·60	2	0·29	-	-	1	0·15	2	0·29
†Stibbington (parish) ..	410	-	-	-	-	-	-	-	-	1	2·44	-	-
*Thrapston (part of) ..	851	-	-	-	-	-	-	-	-	-	-	-	-
County of Kent.													
ADMINISTRATIVE COUNTY	985,147	2	0·00	2,823	2·87	2,076	2·11	214	0·22	32	0·03	603	0·61
COUNTY BOROUGH:—													
Canterbury	24,595	-	-	94	3·82	119	4·84	6	0·24	1	0·04	20	0·81
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	682,086	2	0·00	2,001	2·93	1,381	2·02	174	0·26	23	0·03	461	0·68
AGGREGATE OF RURAL DISTRICTS.	303,061	-	-	822	2·71	695	2·29	40	0·13	9	0·03	142	0·47
BOROUGHS AND URBAN DISTRICTS:—													
Ashford	14,200	-	-	40	2·82	30	2·11	-	-	-	-	4	0·28
Beckenham	31,569	-	-	53	1·68	32	1·01	3	0·10	1	0·03	12	0·38
Bexley	18,660	-	-	99	5·31	10	0·54	-	-	1	0·05	16	0·86
Broadstairs and St. Peter's	9,423	-	-	18	1·91	9	0·96	1	0·11	-	-	7	0·74

* The remaining parts of the Rural Districts of Oundle and Thrapston are in the Administrative County of Northampton.

† This parish is administered by the Rural District Council of Barnack (Soke of Peterborough).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Kent—*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Bromley	32,768	–	–	109	3·33	115	3·51	3	0·09	4	0·12	24	0·73
Chatham	39,248	–	–	119	3·03	96	2·45	4	0·10	1	0·03	26	0·66
Cheriton	4,913	–	–	34	6·92	24	4·88	–	–	1	0·20	2	0·41
Chislehurst	8,341	–	–	20	2·40	15	1·80	2	0·24	–	–	10	1·20
Dartford	22,337	–	–	174	7·79	23	1·03	8	0·36	–	–	23	1·03
Deal	10.566	–	–	40	3·79	9	0·85	–	–	–	–	2	0·19
Dover	38,571	–	–	136	3·53	37	0·96	59	1·53	1	0·03	20	0·52
Erith	35,232	–	–	231	6·56	104	2·95	3	0·09	1	0·03	21	0·60
Faversham	11,272	–	–	37	3·28	21	1·86	1	0·09	–	–	11	0·98
Folkestone	33,209	1	0·03	79	2·38	71	2·14	8	0·24	2	0·06	21	0·63
Footscray	8,738	–	–	5	0·57	5	0·57	–	–	–	–	2	0·23
Gillingham	45,058	–	–	132	2·93	86	1·91	5	0·11	3	0·07	32	0·71
Gravesend	27,808	1	0·04	62	2·23	91	3·27	7	0·25	–	–	28	1·01
Herne Bay	7,238	–	–	18	2·49	7	0·97	2	0·28	–	–	2	0·28
Hythe..	6,698	–	–	34	5·08	–	–	–	–	–	–	2	0·30
Lydd	2,336	–	–	4	1·71	1	0·43	–	–	–	–	4	1·71
Maidstone	32,128	–	–	81	2·52	28	0·87	15	0·47	–	–	28	0·87
Margate	25,278	–	–	51	2·02	47	1·86	6	0·24	–	–	10	0·40
Milton Regis	6,976	–	–	17	2·44	18	2·58	2	0·29	–	–	3	0·43
New Romney	1,222	–	–	2	1·64	4	3·27	–	–	–	–	–	–
Northfleet	14,756	–	–	33	2·24	12	0·81	2	0·14	–	–	8	0·54
Penge	22,218	–	–	49	2·21	24	1·08	–	–	–	–	7	0·32
Queenborough	3,034	–	–	5	1·65	5	1·65	2	0·66	–	–	9	2·97
Ramsgate	25,899	–	–	44	1·70	66	2·55	11	0·42	1	0·04	60	2·32
Rochester	31,125	–	–	75	2·41	72	2·31	3	0·10	2	0·06	21	0·67
Royal Tunbridge Wells ..	33,430	–	–	18	0·54	82	2·45	1	0·03	2	0·06	9	0·27
*Sandgate (part of) ..	1,267	–	–	2	1·58	4	3·16	–	–	–	–	1	0·79
Sandwich	2,957	–	–	–	–	1	0·34	–	–	–	–	–	–
Sevenoaks	8,795	–	–	5	0·57	4	0·45	–	–	1	0·11	3	0·34
Sheerness	16,598	–	–	54	3·25	110	6·63	17	1·02	1	0·06	14	0·84
Sittingbourne	8,463	–	–	36	4·25	33	3·90	4	0·47	–	–	3	0·35
Southborough .. .	6,567	–	–	5	0·76	10	1·52	1	0·15	1	0·15	3	0·46
Tenterden	3,178	–	–	23	7·24	1	0·31	–	–	–	–	–	–
Tonbridge	13,946	–	–	36	2·58	16	1·15	2	0·14	–	–	9	0·65
Walmer	3,808	–	–	6	1·58	3	0·79	1	0·26	–	–	–	–
Whitstable	8,162	–	–	11	1·35	51	6·25	1	0·12	–	–	4	0·49
Wrotham	4,094	–	–	4	0·98	4	0·98	-	-	–	–	–	–
RURAL DISTRICTS :—													
Blean	7,267	–	–	21	2·89	14	1·93	–	–	–	–	2	0·28
Bridge	9,477	–	–	67	7·07	13	1·37	–	–	–	–	3	0·32
Bromley	23.058	–	–	28	1·21	66	2·86	1	0·04	1	0·04	17	0·74
Cranbrook	12,806	–	–	26	2·03	12	0·94	–	–	–	–	4	0·31
Dartford	39,870	–	–	213	5·34	113	2·83	8	0·20	–	–	43	1·08
Dover	7,132	–	–	7	0·98	3	0·42	3	0·42	–	–	1	0·14
East Ashford	13,925	–	–	19	1·36	23	1·65	1	0·07	1	0·07	2	0·14
Eastry	12,683	–	–	32	2·52	23	1·81	–	–	1	0·08	7	0·55
Elham	7,551	–	–	16	2·12	3	0·40	2	0·26	1	0·13	10	1·32
Faversham	14,474	–	–	44	3·04	85	5·87	1	0·07	–	–	4	0·28
Hollingbourn	12,432	–	–	59	4·75	26	2·09	1	0·08	–	–	6	0·48
Hoo	4,059	–	–	16	3·94	10	2·46	1	0·25	–	–	–	–
Isle of Thanet	9,518	–	–	21	2·21	1	0·11	–	–	–	–	6	0·63
Maidstone	16,478	–	–	42	2·55	55	3·34	–	–	–	–	–	–
Malling	23,463	–	–	47	2·00	18	0·77	8	0·34	2	0·09	8	0·34
Milton	12,890	–	–	36	2·79	47	3·65	5	0·39	–	–	4	0·31
Romney Marsh	2,728	–	–	4	1·47	2	0·73	–	–	–	–	1	0·37
Sevenoaks	23,177	–	–	38	1·64	103	4·44	1	0·04	2	0·09	7	0·30
Sheppey	4,231	–	–	11	2·60	19	4·49	4	0·95	–	–	1	0·24
Strood..	15,446	–	–	40	2·59	20	1·29	2	0·13	–	–	10	0·65
Tenterden	5,739	–	–	–	–	–	–	–	–	–	–	–	–
Tonbridge	17,204	–	–	15	0·87	16	0·93	1	0·06	1	0·06	6	0·35
West Ashford	7,453	–	–	20	2·68	23	3·09	1	0·13	–	–	–	–
County of Lancaster.													
ADMINISTRATIVE COUNTY	1,666,488	3	0·00	7,479	4·49	1,508	0·91	524	0·31	87	0·05	1,197	0·72
COUNTY BOROUGHS :—													
Barrow in Furness ..	83,051	–	–	177	2·13	118	1·42	2	0·02	–	–	67	0·81
Blackburn	127,443	–	–	460	3·61	39	0·31	44	0·35	5	0·04	69	0·54
Blackpool	64,208	–	–	318	4·95	33	0·51	34	0·53	8	0·12	27	0·42
Bolton..	172,514	–	–	575	3·33	178	1·03	48	0·28	2	0·01	149	0·86

* The remaining part of the Urban District of Sandgate forms part of the Borough of Folkestone.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Lancaster —*continued.*													
COUNTY BOROUGHS :—													
Bootle	71,617	–	–	269	3·76	72	1·01	16	0·22	3	0·04	40	0·56
Burnley	103,098	–	–	414	4·02	102	0·99	21	0·20	7	0·07	126	1·22
Bury	54,773	–	–	156	2·85	48	0·88	10	0·18	3	0·05	48	0·88
*Liverpool	740,162	–	–	2,975	4·02	1,206	1·63	105	0·14	54	0·07	751	1·01
Manchester	700,319	–	–	2,995	4·28	572	0·82	173	0·25	103	0·15	492	0·70
Oldham	141,781	20	0·14	535	3·77	85	0·60	11	0·08	11	0·08	137	0·97
Preston	111,936	–	–	692	6·18	197	1·76	44	0·39	9	0·08	82	0·73
Rochdale	90,653	–	–	137	1·51	513	5·66	22	0·24	–	–	80	0·88
St. Helens	92,240	–	–	505	5·47	282	3·06	28	0·30	11	0·12	75	0·81
Salford	219,979	1	0·00	996	4·53	235	1·07	79	0·36	22	0·10	169	0·77
Southport	65,866	–	–	303	4·60	74	1·12	5	0·08	6	0·09	42	0·64
Warrington	72,297	–	–	944	13·06	90	1·24	36	0·50	5	0·07	59	0·82
Wigan	86,329	–	–	1,608	18·63	37	0·43	45	0·52	5	0·06	81	0·94
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	1,436,719	3	0·00	6,596	4·59	1,324	0·92	461	0·32	74	0·05	1,091	0·76
AGGREGATE OF RURAL DISTRICTS.	229,769	–	–	883	3·84	181	0·80	63	0·27	13	0·06	103	0·45
BOROUGHS AND URBAN DISTRICTS :—													
Abram	6,782	–	–	135	19·91	7	1·03	1	0·15	–	–	8	1·18
Accrington	43,050	–	–	74	1·72	13	0·30	12	0·28	3	0·07	38	0·88
Adlington	4,416	–	–	28	6·34	–	–	2	0·45	–	–	3	0·68
Ashton in Makerfield ..	21,709	–	–	237	10·92	29	1·34	7	0·32	4	0·18	23	1·06
Ashton under Lyne ..	41,149	–	–	140	3·40	12	0·29	9	0·22	–	–	31	0·75
Aspull	7,849	–	–	93	11·85	2	0·25	6	0·76	2	0·25	9	1·15
Atherton	19,065	–	–	107	5·61	26	1·36	7	0·37	1	0·05	30	1·57
Audenshaw	7,776	–	–	33	4·24	5	0·64	3	0·39	–	–	2	0·26
Bacup	21,325	–	–	57	2·67	10	0·47	2	0·09	1	0·05	26	1·22
Barrowford	5,751	–	–	41	7·13	2	0·35	–	–	–	–	7	1·22
Billinge	4,611	–	–	3	0·65	1	0·22	–	–	–	–	1	0·22
Bispham with Norbreck	2,965	–	–	1	0·34	4	1·35	2	0·67	–	–	1	0·34
Blackrod	3,741	–	–	43	11·49	2	0·53	2	0·53	1	0·27	4	1·07
Brierfield	8,258	–	–	38	4·60	16	1·94	–	–	–	–	12	1·45
Carnforth	3,020	–	–	–	–	–	–	1	0·33	–	–	–	–
Chadderton	27,868	–	–	89	3·19	14	0·50	2	0·07	4	0·14	13	0·47
Chorley	28,930	–	–	56	1·94	4	0·14	6	0·21	–	–	18	0·62
Church	6,507	–	–	6	0·92	–	–	4	0·61	–	–	3	0·46
Clayton le Moors	8,653	–	–	9	1·04	3	0·35	3	0·35	–	–	8	0·92
Clitheroe	12,034	–	–	57	4·74	7	0·58	3	0·25	1	0·08	7	0·58
Colne	25,272	–	–	118	4·67	9	0·36	10	0·40	2	0·08	15	0·59
Crompton	14,552	–	–	61	4·19	3	0·21	2	0·14	1	0·07	16	1·10
Croston	2,056	–	–	9	4·38	–	–	–	–	–	–	1	0·49
Dalton in Furness ..	12,684	–	–	35	2·76	28	2·21	2	0·16	1	0·08	4	0·32
Darwen	38,782	–	–	155	4·00	16	0·41	6	0·15	2	0·05	18	0·46
Denton	17,134	–	–	60	3·50	7	0·41	7	0·41	–	–	13	0·76
Droylsden	13,329	–	–	50	3·75	8	0·60	25	1·88	2	0·15	14	1·05
Eccles	42,274	–	–	145	3·43	70	1·66	16	0·38	1	0·02	17	0·40
Failsworth	16,707	–	–	36	2·15	13	0·78	11	0·66	1	0·06	10	0·60
Farnworth	26,241	–	–	76	2·90	37	1·41	9	0·34	1	0·04	27	1·03
Fleetwood	15,207	–	–	29	1·91	13	0·85	8	0·53	1	0·07	24	1·58
Formby	5,771	–	–	9	1·56	8	1·39	–	–	–	–	–	–
Fulwood	5,717	–	–	20	3·50	7	1·22	1	0·17	–	–	1	0·17
Golborne	6,622	–	–	56	8·46	20	3·02	2	0·30	–	–	8	1·21
Grange	1,901	–	–	13	6·84	8	4·21	–	–	–	–	–	–
Great Crosby	13,065	–	–	97	7·42	19	1·45	4	0·31	–	–	9	0·69
Great Harwood	13,858	–	–	23	1·66	13	0·94	4	0·29	–	–	8	0·58
Haslingden	17,844	–	–	33	1·85	13	0·73	14	0·78	–	–	14	0·78
Haydock	9,194	–	–	28	3·05	6	0·65	1	0·11	–	–	12	1·31
Heysham	3,373	–	–	1	0·30	–	–	1	0·30	–	–	–	–
Heywood	25,809	–	–	171	6·63	40	1·55	3	0·12	–	–	21	0·81
Hindley	23,574	–	–	189	8·02	14	0·59	6	0·25	1	0·04	24	1·02
Horwich	16,003	–	–	242	15·12	42	2·62	2	0·12	–	–	3	0·19
Hurst	7,722	–	–	21	2·72	–	–	3	0·39	2	0·26	5	0·65

* 37 cases of Typhus Fever were notified.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Lancaster —*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Huyton with Roby ..	4,708	–	–	4	0·85	1	0·21	–	–	–	–	–	–
Ince in Makerfield ..	21,728	–	–	324	14·91	9	0·41	6	0·28	3	0·14	18	0·83
Irlam	8,637	–	–	17	1·97	13	1·51	3	0·35	4	0·46	14	1·62
Kearsley	9,607	–	–	18	1·87	11	1·14	3	0·31	–	–	7	0·73
Kirkham	3,616	–	–	30	8·30	4	1·11	–	–	4	1·11	4	1·11
Lancaster	33,861	–	–	61	1·80	29	0·86	17	0·50	1	0·03	33	0·97
Lathom and Burscough..	7,498	–	–	93	12·40	12	1·60	–	–	–	–	2	0·27
Lees	4,717	–	–	15	3·18	1	0·21	–	–	–	–	3	0·64
Leigh	44,014	–	–	390	8·86	45	1·02	23	0·52	3	0·07	64	1·45
Leyland	8,776	–	–	27	3·08	11	1·25	1	0·11	–	–	2	0·23
Litherland	15,631	–	–	56	3·58	28	1·79	3	0·19	2	0·13	7	0·45
Littleborough	11,702	–	–	27	2·31	32	2·73	–	–	–	–	8	0·68
Little Crosby	963	–	–	–	–	4	4·15	–	–	–	–	–	–
Little Hulton	7,978	–	–	10	1·25	10	1·25	4	0·50	1	0·13	10	1·25
Little Lever	4,911	–	–	46	9·37	1	0·20	–	–	–	–	5	1·02
Longridge	4,328	–	–	41	9·47	2	0·46	–	–	–	–	2	0·46
Lytham	8,903	–	–	40	4·49	26	2·92	5	0·56	–	–	–	–
Middleton	27,806	–	–	86	3·09	31	1·11	9	0·32	1	0·04	21	0·76
Milnrow	8,410	–	–	34	4·04	7	0·83	1	0·12	1	0·12	6	0·71
Morecambe	12,782	–	–	16	1·25	2	0·16	1	0·08	–	–	12	0·94
Mossley	12,450	–	–	80	6·43	–	–	2	0·16	–	–	1	0·08
Nelson	40,747	–	–	408	10·01	83	2·04	1	0·02	–	–	23	0·56
Newton in Makerfield ..	17,502	–	–	97	5·54	21	1·20	3	0·17	5	0·29	20	1·14
Norden	4,067	–	–	2	0·49	7	1·72	–	–	–	–	2	0·49
Ormskirk	6,739	–	–	42	6·23	2	0·30	1	0·15	–	–	4	0·59
Orrell	6,853	–	–	68	9·92	3	0·44	9	1·31	–	–	11	1·61
Oswaldtwistle	15,496	–	–	40	2·58	8	0·52	2	0·13	–	–	12	0·77
Padiham	12,437	–	–	39	3·14	11	0·88	2	0·16	1	0·08	13	1·05
Poulton le Fylde .. .	2,456	–	–	3	1·22	–	–	1	0·41	–	–	–	–
Preesall	1,733	–	–	4	2·31	–	–	–	–	–	–	1	0·58
Prescot	8,303	–	–	33	3·97	9	1·08	3	0·36	2	0·24	10	1·20
Prestwich	14,569	–	–	49	3·36	12	0·82	–	–	–	–	6	0·41
Radcliffe	24,565	–	–	156	6·35	9	0·37	4	0·16	–	–	13	0·53
Rainford	3,285	–	–	4	1·22	2	0·61	3	0·91	–	–	5	1·52
Ramsbottom	15,056	–	–	30	1·99	14	0·93	3	0·20	–	–	5	0·33
Rawtenstall..	29,575	–	–	33	1·12	30	1·01	17	0·57	1	0·03	13	0·44
Rishton	7,346	–	–	17	2·31	6	0·82	1	0·14	–	–	12	1·63
Royton	16,981	3	0·18	51	3·00	4	0·24	1	0·06	–	–	19	1·12
St. Anne's on the Sea .	9,933	–	–	18	1·81	11	1·11	1	0·10	–	–	5	0·50
Skelmersdale	6,689	–	–	20	2·99	4	0·60	4	0·60	5	0·75	2	0·30
Standish with Langtree	7,361	–	–	72	9·78	6	0·82	13	1·77	–	–	22	2·99
Stretford	44,042	–	–	163	3·70	30	0·68	6	0·14	2	0·05	19	0·43
Swinton and Pendlebury	30,719	–	–	134	4·36	51	1·66	22	0·72	1	0·03	44	1·43
Thornton	4,859	–	–	3	0·62	–	–	–	–	–	–	–	–
Tottington	6,602	–	–	71	10·75	–	–	1	0·15	2	0·30	2	0·30
Trawden	2,903	–	–	–	–	–	–	–	–	–	–	–	–
Turton	12,237	–	–	29	2·37	2	0·16	8	0·65	–	–	7	0·57
Tyldesley with Shakerley	15,234	–	–	34	2·23	12	0·79	14	0·92	1	0·07	11	0·72
Ulverston	10,199	–	–	4	0·39	2	0·20	1	0·10	–	–	6	0·59
Upholland	5,253	–	–	60	11·42	3	0·57	15	2·86	–	–	4	0·76
Urmston	8,034	–	–	6	0·75	3	0·37	–	–	–	–	–	–
Walton le Dale	11,934	–	–	73	6·12	17	1·42	4	0·34	–	–	3	0·25
Wardle	3,907	–	–	6	1·54	4	1·02	–	–	–	–	4	1·02
Waterloo with Seaforth	27,473	–	–	136	4·95	39	1·42	4	0·15	–	–	26	0·95
Westhoughton	15,333	–	–	95	6·20	12	0·78	9	0·59	1	0·07	11	0·72
Whitefield	6,803	–	–	14	2·06	4	0·59	1	0·15	–	–	4	0·59
Whitworth	8,390	–	–	18	2·15	11	1·31	–	–	–	–	12	1·43
Widnes	30,911	–	–	156	5·05	31	1·00	15	0·49	1	0·03	7	0·23
Withnell	3,319	–	–	–	–	–	–	–	–	–	–	1	0·30
Worsley	13,698	–	–	69	5·04	31	2·26	5	0·37	–	–	8	0·58
RURAL DISTRICTS :—													
Barton upon Irwell ..	9,685	–	–	56	5·78	3	0·31	6	0·62	–	–	4	0·41
Blackburn	8,853	–	–	15	1·69	3	0·34	4	0·45	–	–	1	0·11
Burnley	19,766	–	–	81	4·10	16	0·81	3	0·15	–	–	12	0·61
Bury	9,258	–	–	31	3·35	7	0·76	3	0·32	2	0·22	2	0·22
Chorley	21,947	–	–	73	3·33	11	0·50	8	0·36	1	0·05	12	0·55
Clitheroe	6,203	–	–	49	7·90	6	0·97	–	–	–	–	4	0·64

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Lancaster —*continued.*													
RURAL DISTRICTS :—													
Fylde	11,592	–	–	121	10·44	8	0·69	4	0·35	1	0·09	5	0·43
Garstang	10,457	–	–	9	0·86	–	–	–	–	1	0·10	5	0·48
Lancaster	8,763	–	–	34	3·88	1	0·11	1	0·11	–	–	2	0·23
Leigh	10,375	–	–	28	2·70	5	0·48	6	0·58	–	–	2	0·19
Limehurst	9,007	–	–	26	2·89	2	0·22	2	0·22	2	0·22	3	0·33
Lunesdale	6,588	–	–	6	0·91	4	0·61	1	0·15	–	–	1	0·15
Preston	18,822	–	–	72	3·83	17	0·90	3	0·16	1	0·05	8	0·43
Sefton..	5,377	–	–	6	1·12	–	–	–	–	1	0·19	3	0·56
Ulverston	17,035	–	–	20	1·17	28	1·64	1	0·06	–	–	10	0·59
Warrington	10,903	–	–	74	6·79	24	2·20	10	0·92	–	–	10	0·92
West Lancashire	20,205	–	–	103	5·10	24	1·19	8	0·40	1	0·05	7	0·35
Whiston	18,587	–	–	68	3·66	18	0·97	–	–	3	0·16	7	0·38
Wigan..	6,346	–	–	11	1·73	7	1·10	3	0·47	–	–	5	0·79
County of Leicester.													
ADMINISTRATIVE COUNTY	249,107	–	–	515	2·07	265	1·06	21	0·08	9	0·04	217	0·87
COUNTY BOROUGH :— Leicester	225,907	–	–	333	1·47	153	0·68	14	0·06	21	0·09	335	1·48
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	102,787	–	–	259	2·52	113	1·10	8	0·08	1	0·01	115	1·12
AGGREGATE OF RURAL DISTRICTS.	146,320	–	–	256	1·75	152	1·04	13	0·09	8	0·05	102	0·70
BOROUGHS AND URBAN DISTRICTS :—													
Ashby de la Zouch ..	4,644	–	–	6	1·29	2	0·43	–	–	1	0·22	2	0·43
Ashby Woulds	2,853	–	–	8	2·80	2	0·70	–	–	–	–	2	0·70
Coalville	19,686	–	–	27	1·37	24	1·22	–	–	–	–	20	1·02
Hinckley	13,257	–	–	21	1·58	3	0·23	–	–	–	–	22	1·66
Loughborough	23,724	–	–	85	3·58	18	0·76	2	0·08	–	–	16	0·67
Market Harborough ..	8,753	–	–	16	1·83	26	2·97	–	–	–	–	6	0·69
Melton Mowbray	8,544	–	–	25	2·93	8	0·94	6	0·70	–	–	19	2·22
Oadby..	2,900	–	–	5	1·72	5	1·72	–	–	–	–	3	1·03
Quorndon	2,334	–	–	2	0·86	2	0·86	–	–	–	–	6	2·57
Shepshed	5,454	–	–	46	8·43	9	1·65	–	–	–	–	2	0·37
Thurmaston	2,004	–	–	–	–	–	–	–	–	–	–	5	2·50
Wigston Magna	8,634	–	–	18	2·08	14	1·62	–	–	–	–	12	1·39
RURAL DISTRICTS :—													
Ashby de la Zouch ..	16,297	–	–	20	1·23	29	1·78	1	0·06	2	0·12	23	1·41
Barrow upon Soar ..	23,872	–	–	20	0·84	16	0·67	–	–	–	–	21	0·88
Belvoir	3,181	–	–	4	1·26	3	0·94	1	0·31	1	0·31	1	0·31
Billesdon	6,257	–	–	9	1·44	6	0·96	–	–	1	0·16	1	0·16
Blaby	15,967	–	–	42	2·63	32	2·00	2	0·13	2	0·13	15	0·94
Castle Donington	6,055	–	–	2	0·33	1	0·17	1	0·17	1	0·17	2	0·33
Hallaton	1,849	–	–	–	–	1	0·54	–	–	–	–	–	–
Hinckley	14,469	–	–	20	1·38	11	0·76	2	0·14	–	–	13	0·90
Loughborough	4,212	–	–	15	3·56	–	–	2	0·47	–	–	–	–
Lutterworth	10,007	–	–	9	0·90	12	1·20	1	0·10	–	–	10	1·00
Market Bosworth.. ..	21,925	–	–	81	3·69	12	0·55	1	0·05	–	–	8	0·36
Market Harborough ..	7,466	–	–	6	0·80	–	–	2	0·27	–	–	–	–
Melton Mowbray	14,773	–	–	28	1·90	29	1·96	–	–	1	0·07	8	0·54
County of Lincoln, Parts of Holland.													
ADMINISTRATIVE COUNTY	81,052	–	–	418	5·16	93	1·15	7	0·09	2	0·02	45	0·56
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	35,780	–	–	219	6·12	49	1·37	6	0·17	–	–	26	0·73
AGGREGATE OF RURAL DISTRICTS.	45,272	–	–	199	4·40	44	0·97	1	0·02	2	0·04	19	0·42
BOROUGHS AND URBAN DISTRICTS :—													
Boston	15,565	–	–	186	11·95	39	2·51	6	0·39	–	–	11	0·71
Holbeach	4,992	–	–	12	2·40	4	0·80	–	–	–	–	–	–
Long Sutton	2,884	–	–	2	0·69	5	1·73	–	–	–	–	6	2·08
Spalding	10,184	–	–	11	1·08	1	0·10	–	–	–	–	9	0·88
Sutton Bridge	2,155	–	–	8	3·71	–	–	–	–	–	–	–	–

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Lincoln, Parts of Holland—*continued.*													
RURAL DISTRICTS:—													
Boston	20,897	–	–	159	7·61	34	1·63	1	0·05	1	0·05	17	0·81
Crowland	2,655	–	–	15	5·65	2	0·75	–	–	–	–	1	0·38
East Elloe	8,677	–	–	14	1·61	2	0·23	–	–	–	–	1	0·12
Spalding	13,043	–	–	11	0·84	6	0·46	–	–	1	0·08	–	–
County of Lincoln, Parts of Kesteven.													
ADMINISTRATIVE COUNTY	106,814	–	–	193	1·81	214	2·00	11	0·10	5	0·05	41	0·38
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	41,442	–	–	72	1·74	149	3·60	9	0·22	1	0·02	17	0·41
AGGREGATE OF RURAL DISTRICTS.	65,372	–	–	121	1·85	65	0·99	2	0·03	4	0·06	24	0·37
BOROUGHS AND URBAN DISTRICTS:—													
Bourne	4,105	–	–	2	0·49	9	2·19	1	0·24	–	–	–	–
Bracebridge..	2,264	–	–	1	0·44	–	–	–	–	–	–	–	–
Grantham	19,248	–	–	62	3·22	52	2·70	4	0·21	1	0·05	13	0·68
Ruskington	1,158	–	–	2	1·73	–	–	–	–	–	–	–	–
Sleaford	5,610	–	–	3	0·53	1	0·18	4	0·71	–	–	4	0·71
Stamford	9,057	–	–	2	0·22	87	9·61	–	–	–	–	–	–
RURAL DISTRICTS:—													
Bourne	12,774	–	–	18	1·41	4	0·31	–	–	1	0·08	4	0·31
Branston	14,858	–	–	22	1·48	11	0·74	2	0·13	1	0·07	4	0·27
Claypole	7,625	–	–	21	2·75	7	0·92	–	–	1	0·13	6	0·79
Grantham	12,183	–	–	45	3·69	38	3·12	–	–	–	–	7	0·57
Sleaford	16,421	–	–	11	0·67	4	0·24	–	–	1	0·06	2	0·12
Uffington	1,511	–	–	4	2·65	1	0·66	–	–	–	–	1	0·66
County of Lincoln, Parts of Lindsey.													
ADMINISTRATIVE COUNTY	234,483	–	–	544	2·32	231	0·99	29	0·12	2	0·01	114	0·49
COUNTY BOROUGHS:—													
Grimsby	72,126	–	–	145	2·01	80	1·11	14	0·19	2	0·03	14	0·19
Lincoln	55,226	–	–	118	2·14	59	1·07	3	0·05	1	0·02	40	0·72
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	95,702	–	–	199	2·08	118	1·23	14	0·15	–	–	63	0·66
AGGREGATE OF RURAL DISTRICTS.	138,781	–	–	345	2·49	113	0·81	15	0·11	2	0·01	51	0·37
BOROUGHS AND URBAN DISTRICTS:—													
Alford..	2,123	–	–	4	1·88	3	1·41	–	–	–	–	2	0·94
Barton upon Humber ..	6,288	–	–	3	0·48	–	–	–	–	–	–	9	1·43
Brigg	3,119	–	–	–	–	2	0·64	2	0·64	–	–	3	0·96
Broughton	1,555	–	–	–	–	–	–	–	–	–	–	–	–
Brumby and Frodingham	3,500	–	–	20	5·71	24	6·86	–	–	–	–	1	0·29
Cleethorpe with Thrunscoe.	23,496	–	–	30	1·28	48	2·04	3	0·13	–	–	12	0·51
Crowle	2,855	–	–	7	2·45	–	–	1	0·35	–	–	–	–
Gainsborough	18,826	–	–	73	3·88	–	–	3	0·16	–	–	19	1·01
Horncastle	3,523	–	–	9	2·56	1	0·28	–	–	–	–	2	0·57
Louth	9,261	–	–	23	2·48	6	0·65	3	0·32	–	–	3	0·32
Mablethorpe	1,445	–	–	2	1·38	1	0·69	–	–	–	–	–	–
Market Rasen	2,113	–	–	1	0·47	1	0·47	–	–	–	–	–	–
Roxby cum Risby ..	518	–	–	–	–	–	–	–	–	–	–	–	–
Scunthorpe	10,540	–	–	23	2·18	25	2·37	–	–	–	–	7	0·66
Skegness	3,622	–	–	2	0·55	3	0·83	–	–	–	–	1	0·28
Winterton	1,463	–	–	1	0·68	4	2·73	2	1·37	–	–	–	–
Woodhall Spa	1,455	–	–	1	0·69	–	–	–	–	–	–	4	2·75

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Lincoln, Parts of Lindsey—*continued.*													
RURAL DISTRICTS:—													
Caistor	12,473	–	–	13	1·04	12	0·96	–	–	–	–	6	0·48
Gainsborough	13,979	–	–	72	5·15	12	0·86	–	–	–	–	6	0·43
Glanford Brigg	31,772	–	–	31	0·98	4	0·13	9	0·28	2	0·06	9	0·28
Grimsby	10,426	–	–	7	0·67	9	0·86	2	0·19	–	–	–	–
Horncastle	12,500	–	–	96	7·68	–	–	–	–	–	–	2	0·16
Isle of Axholme	6,521	–	–	25	3·83	–	–	–	–	–	–	2	0·31
Louth	17,438	–	–	43	2·47	14	0·80	–	–	–	–	7	0·40
Sibsey	2,890	–	–	16	5·54	1	0·35	1	0·35	–	–	2	0·69
Spilsby	20,038	–	–	32	1·60	22	1·10	2	0·10	–	–	15	0·75
Welton	10,744	–	–	10	0·93	39	3·63	1	0·09	–	–	2	0·19
County of Middlesex.													
ADMINISTRATIVE COUNTY	1,184,250	1	0·00	3,785	3·20	1,799	1·52	139	0·12	52	0·04	731	0·62
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	1,133,625	1	0·00	3,607	3·18	1,671	1·47	130	0·11	48	0·04	707	0·62
AGGREGATE OF RURAL DISTRICTS.	50,625	–	–	178	3·52	128	2·53	9	0·18	4	0·08	24	0·47
BOROUGHS AND URBAN DISTRICTS:—													
Acton	58,238	–	–	157	2·70	73	1·25	4	0·07	1	0·02	36	0·62
Brentford	16,068	–	–	69	4·29	25	1·56	1	0·06	–	–	15	0·93
Chiswick	38,445	–	–	54	1·40	44	1·14	2	0·05	2	0·05	26	0·68
Ealing	66,181	–	–	454	6·86	56	0·85	10	0·15	1	0·02	36	0·54
Edmonton	68,143	–	–	305	4·48	110	1·61	13	0·19	7	0·10	96	1·41
Enfield	61,218	–	–	146	2·38	94	1·54	17	0·28	2	0·03	37	0·60
Feltham	5,124	–	–	9	1·76	–	–	3	0·59	–	–	6	1·17
Finchley	44,185	–	–	162	3·67	79	1·79	4	0·09	5	0·11	32	0·72
Friern Barnet	13,238	–	–	29	2·19	22	1·66	6	0·45	–	–	11	0·83
Greenford	1,183	–	–	10	8·45	6	5·07	–	–	–	–	2	1·69
Hampton	9,202	–	–	12	1·30	22	2·39	2	0·22	1	0·11	6	0·65
Hampton Wick	2,474	–	–	2	0·81	9	3·64	–	–	–	–	–	–
Hanwell	19,775	–	–	114	5·76	34	1·72	–	–	1	0·05	13	0·66
Harrow on the Hill ..	17,165	–	–	69	4·02	11	0·64	2	0·12	–	–	8	0·47
Hayes	5,066	–	–	7	1·38	32	6·32	–	–	2	0·39	3	0·59
Hendon	53,184	–	–	113	2·12	63	1·18	6	0·11	2	0·04	22	0·41
Heston and Isleworth ..	41,836	1	0·02	96	2·29	92	2·20	–	–	7	0·17	29	0·69
Hornsey	82,365	–	–	177	2·15	108	1·31	18	0·22	5	0·06	34	0·41
Kingsbury	874	–	–	1	1·14	–	–	–	–	–	–	–	–
Ruislip Northwood ..	7,263	–	–	8	1·10	42	5·78	–	–	–	–	–	–
Southall Norwood ..	25,480	–	–	110	4·32	29	1·14	5	0·20	–	–	13	0·51
Southgate	38,231	–	–	90	2·35	43	1·12	2	0·05	1	0·03	19	0·50
Staines	6,468	–	–	8	1·24	6	0·93	1	0·15	–	–	6	0·93
Sunbury on Thames ..	4,805	–	–	4	0·83	3	0·62	–	–	–	–	2	0·42
Teddington	18,282	–	–	28	1·53	11	0·60	4	0·22	1	0·05	19	1·04
Tottenham	143,267	–	–	514	3·59	233	1·63	8	0·06	2	0·01	79	0·55
Twickenham	33,083	–	–	32	0·97	50	1·51	1	0·03	1	0·03	10	0·30
Uxbridge	10,092	–	–	98	9·71	11	1·09	5	0·50	–	–	11	1·09
Wealdstone	12,504	–	–	81	6·48	14	1·12	1	0·08	–	–	11	0·88
Wembley	14,433	–	–	27	1·87	12	0·83	2	0·14	–	–	4	0·28
Willesden	160,778	–	–	438	2·72	228	1·42	9	0·06	5	0·03	78	0·49
Wood Green	50,545	–	–	150	2·97	101	2·00	3	0·06	2	0·04	43	0·85
Yiewsley	4,430	–	–	33	7·45	8	1·81	1	0·23	–	–	–	–
RURAL DISTRICTS:—													
Hendon	16,603	–	–	65	3·92	11	0·66	3	0·18	1	0·06	4	0·24
South Mimms	2,791	–	–	13	4·66	4	1·43	–	–	–	–	–	–
Staines	21,909	–	–	78	3·56	93	4·25	2	0·09	1	0·05	17	0·78
Uxbridge	9,322	–	–	22	2·36	20	2·15	4	0·43	2	0·21	3	0·32

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Norfolk.													
ADMINISTRATIVE COUNTY	303,780	–	–	1,044	3·44	255	0·84	61	0·20	5	0·02	74	0·24
COUNTY BOROUGHS :—													
Great Yarmouth	50,475	–	–	112	2·22	123	2·44	14	0·28	1	0·02	36	0·71
Norwich	115,902	–	–	240	2·07	305	2·63	23	0·20	7	0·06	49	0·42
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	58,220	–	–	254	4·36	50	0·86	11	0·19	1	0·02	18	0·31
AGGREGATE OF RURAL DISTRICTS.	245,560	–	–	790	3·22	205	0·83	50	0·20	4	0·02	56	0·23
BOROUGHS AND URBAN DISTRICTS :—													
Cromer	3,642	–	–	1	0·27	1	0·27	–	–	–	–	–	–
Diss	3,552	–	–	–	–	1	0·28	–	–	–	–	–	–
Downham Market ..	2,266	–	–	8	3·53	–	–	–	–	–	–	–	–
East Dereham	5,567	–	–	7	1·26	1	0·18	–	–	–	–	1	0·18
King's Lynn..	19,380	–	–	186	9·60	12	0·62	7	0·36	1	0·05	12	0·62
New Hunstanton	2,425	–	–	5	2·06	–	–	–	–	–	–	–	–
North Walsham	4,179	–	–	6	1·44	7	1·68	–	–	–	–	–	–
Sheringham.. .. .	3,342	–	–	3	0·90	2	0·60	–	–	–	–	–	–
Swaffham	2,866	–	–	4	1·40	1	0·35	–	–	–	–	1	0·35
Thetford	4,707	–	–	28	5·95	1	0·21	–	–	–	–	3	0·64
Walsoken	3,874	–	–	5	1·29	15	3·87	1	0·26	–	–	1	0·26
Wells	2,420	–	–	1	0·41	9	3·72	3	1·24	–	–	–	–
RURAL DISTRICTS :—													
Aylsham	16,344	–	–	81	4·96	14	0·86	1	0·06	–	–	7	0·43
Blofield	10,745	–	–	20	1·86	7	0·65	2	0·19	–	–	4	0·37
Depwade	18,543	–	–	76	4·10	1	0·05	–	–	1	0·05	9	0·49
Docking	16,114	–	–	94	5·83	20	1·24	7	0·43	–	–	5	0·31
Downham	15,132	–	–	82	5·42	1	0·07	4	0·26	–	–	2	0·13
East and West Flegg ..	9,61[illegible]	–	–	9	0·94	18	1·87	1	0·10	–	–	1	0·10
Erpingham	16,144	–	–	40	2·48	8	0·50	–	–	2	0·12	1	0·06
Forehoe	10,782	–	–	7	0·65	9	0·83	–	–	–	–	2	0·19
Freebridge Lynn	11,[illegible]37	–	–	45	3·90	14	1·21	1	0·09	–	–	2	0·17
Henstead	9,960	–	–	12	1·20	23	2·31	–	–	–	–	1	0·10
King's Lynn	940	–	–	3	3·19	3	3·19	–	–	–	–	1	1·06
Loddon and Clavering ..	11,964	–	–	31	2·59	19	1·59	–	–	–	–	7	0·59
Marshland	12,732	–	–	22	1·73	16	1·26	18	1·41	1	0·08	1	0·08
Mitford and Launditch ..	16,961	–	–	77	4·54	4	0·24	3	0·18	–	–	3	0·18
St. Faith's	9,493	–	–	33	3·48	17	1·79	3	0·32	–	–	2	0·21
Smallburgh	13,059	–	–	39	2·99	16	1·23	3	0·23	–	–	5	0·38
Swaffham	7,217	–	–	12	1·66	1	0·14	–	–	–	–	1	0·14
Thetford	9,095	–	–	37	4·07	–	–	–	–	–	–	1	0·11
Walsingham	16,619	–	–	62	3·73	12	0·72	7	0·42	–	–	–	–
Wayland	12,564	–	–	8	0·64	2	0·16	–	–	–	–	1	0·08
County of Northampton.													
ADMINISTRATIVE COUNTY	210,360	–	–	510	2·42	639	3·04	25	0·12	12	0·06	142	0·68
COUNTY BOROUGH :—													
Northampton	90,296	–	–	685	7·59	306	3·39	18	0·20	8	0·09	96	1·06
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	96,037	–	–	209	2·18	286	2·98	9	0·09	4	0·04	62	0·65
AGGREGATE OF RURAL DISTRICTS.	114,323	–	–	301	2·63	353	3·09	16	0·14	8	0·07	80	0·70
BOROUGHS AND URBAN DISTRICTS :—													
Brackley	2,179	–	–	9	4·13	–	–	–	–	–	–	1	0·46
Daventry	3,247	–	–	4	1·23	1	0·31	–	–	–	–	2	0·62
Desborough	4,167	–	–	4	0·96	8	1·92	–	–	–	–	3	0·72
Finedon	4,040	–	–	5	1·24	44	10·89	1	0·25	–	–	2	0·50
Higham Ferrers	2,849	–	–	2	0·70	–	–	–	–	–	–	–	–
Irthlingborough . ..	4,790	–	–	9	1·88	1	0·21	1	0·21	–	–	1	0·21
Kettering	30,453	–	–	64	2·10	93	3·05	2	0·07	2	0·07	30	0·99
Oundle	2,287	–	–	4	1·75	–	–	–	–	1	0·44	3	1·31
Raunds	4,081	–	–	22	5·39	–	–	–	–	–	–	7	1·72
Rothwell	4,455	–	–	9	2·02	11	2·47	–	–	–	–	2	0·45
Rushden	13,787	–	–	24	1·74	21	1·52	1	0·07	–	–	18	1·31
Wellingborough	19,702	–	–	53	2·69	107	5·43	4	0·20	1	0·05	23	1·17

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Northampton—*continued.*													
RURAL DISTRICTS :—													
Brackley	6,820	–	–	11	1·61	8	1·17	–	–	–	–	6	0·88
Brixworth	11,559	–	–	28	2·42	20	1·73	3	0·26	–	–	8	0·69
Crick	2,406	–	–	38	15·79	–	–	–	–	–	–	–	–
Daventry	13,544	–	–	39	2·88	19	1·40	1	0·07	3	0·22	9	0·66
Easton on the Hill ..	1,429	–	–	–	–	12	8·40	–	–	–	–	–	–
Gretton	1,487	–	–	–	–	1	0·67	–	–	–	–	–	–
Hardingstone	7,428	–	–	10	1·35	17	2·29	1	0·13	–	–	–	–
Kettering	12,758	–	–	14	1·10	123	9·64	1	0·08	–	–	30	2·35
Middleton Cheney ..	2,467	–	–	28	11·35	–	–	–	–	–	–	1	0·41
Northampton	5,741	–	–	16	2·79	11	1·92	2	0·35	–	–	–	–
*Oundle (part of)	6,625	–	–	21	3·17	3	0·45	–	–	–	–	5	0·75
Oxendon	4,178	–	–	9	2·15	2	0·48	–	–	1	0·24	3	0·72
Potterspury	4,792	–	–	2	0·42	2	0·42	–	–	1	0·21	2	0·42
*Thrapston (part of) ..	10,502	–	–	12	1·14	5	0·48	–	–	1	0·10	4	0·38
Towcester	9,864	–	–	35	3·55	9	0·91	2	0·20	1	0·10	3	0·30
Wellingborough	12,723	–	–	38	2·99	121	9·51	6	0·47	1	0·08	9	0·71
County of Peterborough, Soke of.													
ADMINISTRATIVE COUNTY	45,968	–	–	210	4·57	44	0·96	2	0·04	3	0·07	21	0·46
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	34,827	–	–	191	5·48	15	0·43	2	0·06	2	0·06	14	0·40
AGGREGATE OF RURAL DISTRICTS.	11,141	–	–	19	1·71	29	2·60	–	–	1	0·09	7	0·63
BOROUGHS AND URBAN DISTRICTS :—													
Peterborough	34,827	–	–	191	5·48	15	0·43	2	0·06	2	0·06	14	0·40
RURAL DISTRICTS :—													
Barnack	1,992	–	–	–	–	11	5·52	–	–	–	–	1	0·50
Peterborough	9,149	–	–	19	2·08	18	1·97	–	–	1	0·11	6	0·66
County of Northumberland.													
ADMINISTRATIVE COUNTY	364,347	–	–	1,628	4·47	520	1·43	80	0·22	8	0·02	200	0·55
COUNTY BOROUGHS :—													
‡Newcastle upon Tyne ..	278,107†	–	–	1,337	4·81	243	0·87	90	0·32	21	0·08	170	0·61
‡Tynemouth	58,199	–	–	130	2·23	61	1·05	122	2·10	2	0·03	45	0·77
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS	267,215	–	–	1,178	4·41	390	1·46	68	0·25	7	0·03	142	0·53
AGGREGATE OF RURAL DISTRICTS.	97,132	–	–	450	4·63	130	1·34	12	0·12	1	0·01	58	0·60
BOROUGHS AND URBAN DISTRICTS :—													
Alnwick	6,607	–	–	3	0·45	5	0·76	–	–	–	–	–	–
Amble..	4,177	–	–	9	2·15	9	2·15	–	–	–	–	–	–
Ashington	25,409	–	–	285	11·22	88	3·46	3	0·12	2	0·08	15	0·59
Bedlingtonshire	23,976	–	–	25	1·04	19	0·79	14	0·58	–	–	14	0·58
Berwick upon Tweed ..	11,731	–	–	27	2·30	12	1·02	4	0·34	1	0·09	1	0·09
Blyth	29,196	–	–	54	1·85	20	0·69	7	0·24	1	0·03	20	0·69
Cramlington	7,445	–	–	32	4·30	7	0·94	3	0·40	–	–	–	–
Earsdon	10,371	–	–	18	1·74	26	2·51	5	0·48	–	–	4	0·39
Gosforth	14,077	–	–	52	3·69	9	0·64	2	0·14	–	–	2	0·14
Hexham	7,972	–	–	62	7·78	16	2·01	–	–	–	–	5	0·63
Longbenton	12,473	–	–	55	4·41	8	0·64	1	0·08	–	–	12	0·96
Morpeth	6,756	–	–	5	0·74	–	–	3	0·44	–	–	–	–
Newbiggin by the Sea ..	5,055	–	–	2	0·40	8	1·58	–	–	–	–	5	0·99

* The remaining parts of the Rural Districts of Oundle and Thrapston are in the Administrative County of Huntingdon. The figures for the entire Districts are as follows :—

Oundle	7,695	–	–	21	2·73	3	0·39	–	–	–	–	6	0·78
Thrapston	11,353	–	–	12	1·06	5	0·44	–	–	1	0·09	4	0·35

† Including Moot Hall and precincts.
‡ 1 case of Typhus Fever was notified.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Northumberland—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Newburn	18,115	–	–	113	6·24	33	1·82	15	0·83	1	0·06	17	0·94
Prudhoe	7,807	–	–	77	9·86	25	3·20	1	0·13	–	–	10	1·28
Rothbury	1,078	–	–	–	–	1	0·93	–	–	–	–	1	0·93
Seaton Delaval	6,626	–	–	27	4·07	21	3·17	–	–	–	–	5	0·75
Seghill	1,979	–	–	–	–	–	–	–	–	–	–	–	–
Wallsend	43,093	–	–	229	5·31	49	1·14	3	0·07	1	0·02	20	0·46
Weetslade	6,253	–	–	54	8·64	12	1·92	–	–	–	–	5	0·80
Whitley and Monkseaton	17,019	–	–	49	2·88	22	1·29	7	0·41	1	0·06	6	0·35
RURAL DISTRICTS:—													
Alnwick	11,291	–	–	16	1·42	8	0·71	–	–	1	0·09	7	0·62
Belford	4,621	–	–	1	0·22	1	0·22	–	–	–	–	3	0·65
Bellingham	5,750	–	–	11	1·91	14	2·43	1	0·17	–	–	4	0·70
Castle Ward..	10,989	–	–	146	13·29	26	2·37	4	0·36	–	–	10	0·91
Glendale	8,089	–	–	23	2·84	8	0·99	–	–	–	–	3	0·37
Haltwistle	9,121	–	–	15	1·64	16	1·75	–	–	–	–	3	0·33
Hexham	21,356	–	–	142	6·65	32	1·50	1	0·05	–	–	11	0·52
Morpeth	15,936	–	–	55	3·45	21	1·32	6	0·38	–	–	12	0·75
Norham and Islandshires.	5,466	–	–	22	4·02	1	0·18	–	–	–	–	5	0·91
Rothbury	4,513	–	–	19	4·21	3	c·66	–	–	–	–	–	–
County of Nottingham.													
ADMINISTRATIVE COUNTY	353,193	–	–	1106	3·13	489	1·38	40	0·11	19	0·05	229	0·65
COUNTY BOROUGH:—													
Nottingham..	240,588	–	–	1235	5·13	182	0·76	29	0·12	8	0·03	221	0·92
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	226,656	–	–	781	3·45	373	1·65	27	0·12	13	0·06	170	0·75
AGGREGATE OF RURAL DISTRICTS.	126,537	–	–	325	2·57	116	0·92	13	0·10	6	0·05	59	0·47
BOROUGHS AND URBAN DISTRICTS:—													
Arnold	11,388	–	–	22	1·93	7	0·61	1	0·09	1	0·09	2	0·18
Beeston	11,324	–	–	48	4·24	2	0·18	1	0·09	–	–	7	0·62
Carlton	16,992	–	–	109	6·41	13	0·77	1	0·06	1	0·06	22	1·29
East Retford	12,545	–	–	31	2·47	6	0·48	–	–	1	0·08	16	1·28
Eastwood	4,831	–	–	12	2·48	5	1·03	1	0·21	–	–	–	–
Hucknall Torkard ..	15,497	–	–	48	3·10	8	0·52	–	–	–	–	7	0·45
Huthwaite	5,453	–	–	35	6·42	8	1·47	–	–	1	0·18	5	0·92
Kirkby in Ashfield ..	16,322	–	–	48	2·94	18	1·10	3	0·18	–	–	26	1·59
Mansfield	41,415	–	–	148	3·57	87	2·10	5	0·12	7	0·17	44	1·06
Mansfield Woodhouse ..	12,571	–	–	55	4·38	24	1·91	–	–	1	0·08	7	0·56
Newark	15,759	–	–	32	2·03	142	9·01	2	0·13	–	–	9	0·57
Sutton in Ashfield ..	23,487	–	–	41	1·75	13	0·55	12	0·51	–	–	12	0·51
Warsop	5,261	–	–	21	3·99	8	1·52	–	–	1	0·19	2	0·38
West Bridgford	13,119	–	–	50	3·81	16	1·22	1	0·08	–	–	7	0·53
Worksop	20,692	–	–	81	3·91	16	0·77	–	–	–	–	4	0·19
RURAL DISTRICTS:—													
Basford	41,674	–	–	155	3·72	42	1·01	5	0·12	3	0·07	18	0·43
Bingham	13,616	–	–	30	2·20	22	1·62	3	0·22	–	–	8	0·59
Blyth and Cuckney ..	4,667	–	–	14	3·00	5	1·07	–	–	–	–	–	–
East Retford	13,948	–	–	15	1·08	–	–	2	0·14	1	0·07	3	0·22
*Kingston and Ratcliffe on Soar (parishes).	393	–	–	–	–	–	–	–	–	–	–	–	–
Leake	3,546	–	–	1	0·28	–	–	1	0·28	–	–	1	0·28
Misterton	3,966	–	–	14	3·53	1	0·25	–	–	–	–	1	0·25
Newark	7,950	–	–	27	3·40	20	2·52	–	–	1	0·13	4	0·50
Skegby	7,764	–	–	12	1·55	9	1·16	1	0·13	–	–	2	0·26
Southwell	19,215	–	–	40	2·08	15	0·78	–	–	1	0·05	7	0·36
Stapleford	9,798	–	–	17	1·74	2	0·20	1	0·10	–	–	15	1·53

* These Parishes are administered by the Rural District Council of Shardlow (Derbyshire).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Oxford.													
ADMINISTRATIVE COUNTY	126,412	–	–	354	2·80	45	0·36	3	0·02	3	0·02	67	0·53
COUNTY BOROUGH :— Oxford	49,027	–	–	42	0·86	24	0·49	4	0·08	2	0·04	21	0·43
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	32,983	–	–	110	3·34	15	0·45	1	0·03	–	–	25	0·76
AGGREGATE OF RURAL DISTRICTS.	93,429	–	–	244	2·61	30	0·32	2	0·02	3	0·03	42	0·45
BOROUGHS AND URBAN DISTRICTS :—													
Banbury	12,199	–	–	66	5·41	2	0·16	–	–	–	–	11	0·90
Bicester	2,936	–	–	–	–	6	2·04	–	–	–	–	1	0·34
Chipping Norton	3,317	–	–	14	4·22	–	–	1	0·30	–	–	4	1·21
Henley upon Thames ..	6,316	–	–	14	2·22	5	0·79	–	–	–	–	1	0·16
Thame	2,624	–	–	5	1·91	–	–	–	–	–	–	2	0·76
Wheatley	916	–	–	–	–	–	–	–	–	–	–	–	–
Witney	3,388	–	–	11	3·25	1	0·30	–	–	–	–	5	1·48
Woodstock	1,287	–	–	–	–	1	0·78	–	–	–	–	1	0·78
RURAL DISTRICTS :—													
Banbury	10,776	–	–	56	5·20	6	0·56	–	–	–	–	3	0·28
Bicester	8,680	–	–	18	2·07	1	0·12	–	–	–	–	9	1·04
Chipping Norton	10,602	–	–	16	1·51	2	0·19	1	0·09	1	0·09	9	0·85
Crowmarsh	4,815	–	–	3	0·62	–	–	–	–	–	–	2	0·42
Culham	2,416	–	–	–	–	2	0·83	–	–	–	–	–	–
Goring	2,920	–	–	1	0·34	3	1·03	–	–	–	–	–	–
Headington	12,086	–	–	16	1·32	2	0·17	–	–	2	0·17	4	0·33
Henley	9,756	–	–	9	0·92	7	0·72	–	–	–	–	1	0·10
Thame	5,127	–	–	20	3·90	–	–	–	–	–	–	1	0·20
Witney	15,971	–	–	60	3·76	3	0·19	1	0·06	–	–	6	0·38
Woodstock	10,280	–	–	45	4·38	4	0·39	–	–	–	–	7	0·68
County of Rutland.													
ADMINISTRATIVE COUNTY	18,420	–	–	20	1·09	39	2·12	1	0·05	–	–	11	0·60
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	3,297	–	–	1	0·30	3	0·91	1	0·30	–	–	2	0·61
AGGREGATE OF RURAL DISTRICTS.	15,123	–	–	19	1·26	36	2·38	–	–	–	–	9	0·60
BOROUGHS AND URBAN DISTRICTS :—													
Oakham	3,297	–	–	1	0·30	3	0·91	1	0·30	–	–	2	0·61
RURAL DISTRICTS :—													
Ketton	2,717	–	–	–	–	4	1·47	–	–	–	–	1	0·37
Oakham	6,446	–	–	4	0·62	9	1·40	–	–	–	–	6	0·93
Uppingham	5,960	–	–	15	2·52	23	3·86	–	–	–	–	2	0·34
County of Salop.													
ADMINISTRATIVE COUNTY	232,508	–	–	511	2·20	325	1·40	7	0·03	12	0·05	90	0·39
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	107,391	–	–	207	1·93	202	1·88	5	0·05	4	0·04	48	0·45
AGGREGATE OF RURAL DISTRICTS.	125,117	–	–	304	2·43	123	0·98	2	0·02	8	0·06	42	0·34
BOROUGHS AND URBAN DISTRICTS :—													
Bishop's Castle ..	1,250	–	–	–	–	–	–	–	–	–	–	2	1·60
Bridgnorth	5,218	–	–	3	0·57	1	0·19	1	0·19	–	–	1	0·19
Church Stretton	1,296	–	–	–	–	–	–	–	–	–	–	–	–
Dawley	7,021	–	–	1	0·14	–	–	–	–	–	–	1	0·14

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Salop—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Ellesmere	1,824	–	–	2	1·10	–	–	1	0·55	1	0·55	2	1·10
Ludlow	5,504	–	–	59	10·72	5	0·91	–	–	–	–	3	0·55
Market Drayton ..	4,434	–	–	–	–	11	2·48	–	–	–	–	1	0·23
Newport	2,920	–	–	–	–	–	–	–	–	–	–	1	0·34
Oakengates	11,063	–	–	10	0·90	19	1·72	–	–	–	–	6	0·54
Oswestry	9,955	–	–	33	3·31	70	7·03	1	0·10	–	–	2	0·20
Shrewsbury..	28,575	–	–	57	1·99	67	2·34	1	0·03	1	0·03	18	0·63
Wellington	7,216	–	–	4	0·55	9	1·25	–	–	–	–	7	0·97
Wem	2,124	–	–	24	11·30	–	–	1	0·47	–	–	1	0·47
Wenlock	13,346	–	–	10	0·75	12	0·90	–	–	2	0·15	2	0·15
Whitchurch..	5,645	–	–	4	0·71	8	1·42	–	–	–	–	1	0·18
RURAL DISTRICTS:—													
Atcham	19,916	–	–	25	1·26	18	0·90	–	–	1	0·05	10	0·50
Bridgnorth	8,669	–	–	16	1·85	1	0·12	1	0·12	–	–	–	–
Burford	1,143	–	–	–	–	1	0·87	–	–	–	–	–	–
Chirbury	3,050	–	–	4	1·31	1	0·33	–	–	1	0·33	2	0·66
Church Stretton	4,513	–	–	1	0·22	6	1·33	–	–	–	–	–	–
Cleobury Mortimer ..	7,065	–	–	33	4·67	2	0·28	1	0·14	–	–	3	0·42
Clun	6,263	–	–	14	2·24	2	0·32	–	–	1	0·16	2	0·32
Drayton	7,084	–	–	9	1·27	9	1·27	–	–	–	–	4	0·56
Ellesmere	7,955	–	–	31	3·90	12	1·51	–	–	–	–	3	0·38
Ludlow	9,170	–	–	12	1·31	2	0·22	–	–	1	0·11	6	0·65
Newport	5,409	–	–	10	1·85	18	3·33	–	–	–	–	1	0·18
Oswestry	14,784	–	–	72	4·87	18	1·22	–	–	1	0·07	5	0·34
Shifnal	7,447	–	–	11	1·48	9	1·21	–	–	–	–	–	–
Teme	1,577	–	–	1	0·63	–	–	–	–	–	–	–	–
Wellington	10,805	–	–	25	2·31	13	1·20	–	–	–	–	4	0·37
Wem	8,296	–	–	38	4·58	5	0·60	–	–	3	0·36	1	0·12
Whitchurch..	1,971	–	–	2	1·01	6	3·04	–	–	–	–	1	0·51
County of Somerset.													
ADMINISTRATIVE COUNTY	368,858	–	–	830	2·25	373	1·01	36	0·10	8	0·02	151	0·41
COUNTY BOROUGH:—													
Bath	63,452	–	–	191	3·01	119	1·88	7	0·11	3	0·05	51	0·80
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	150,057	–	–	449	2·99	140	0·93	5	0·03	5	0·03	58	0·39
AGGREGATE OF RURAL DISTRICTS.	218,801	–	–	381	1·74	233	1·06	31	0·14	3	0·01	93	0·43
BOROUGHS AND URBAN DISTRICTS:—													
Bridgwater	15,133	–	–	11	0·73	3	0·20	–	–	–	–	3	0·20
Burnham	4,284	–	–	7	1·63	2	0·47	–	–	–	–	1	0·23
Chard	4,114	–	–	1	0·24	–	–	–	–	–	–	4	0·97
Clevedon	5,617	–	–	5	0·89	1	0·18	–	–	–	–	–	–
Crewkerne	3,861	–	–	3	0·78	1	0·26	–	–	–	–	1	0·26
Frome..	10,240	–	–	1	0·10	–	–	–	–	1	0·10	4	0·39
Glastonbury	3,908	–	–	71	18·17	5	1·28	–	–	–	–	1	0·26
Highbridge	2,292	–	–	–	–	–	–	–	–	–	–	–	–
Ilminster	2,386	–	–	–	–	–	–	–	–	1	0·42	–	–
Midsomer Norton.. ..	7,554	–	–	16	2·12	5	0·66	–	–	–	–	2	0·26
Minehead	3,675	–	–	8	2·18	–	–	–	–	–	–	–	–
Portishead	3,472	–	–	7	2·02	1	0·29	–	–	–	–	–	–
Radstock	3,612	–	–	2	0·55	5	1·38	–	–	1	0·28	2	0·55
Shepton Mallet	4,120	–	–	9	2·18	1	0·24	–	–	–	–	6	1·46
Street	4,082	–	–	76	18·62	1	0·24	2	0·49	–	–	6	1·47
Taunton	21,219	–	–	38	1·79	54	2·55	1	0·05	–	–	7	0·33
Watchet	1,699	–	–	2	1·18	–	–	–	–	–	–	–	–
Wellington	7,362	–	–	36	4·89	1	0·14	–	–	–	–	–	–
Wells	4,290	–	–	23	5·36	5	1·17	–	–	–	–	2	0·47
Weston super Mare ..	22,372	–	–	57	2·55	34	1·52	2	0·09	–	–	7	0·31
Wiveliscombe	1,326	–	–	1	0·75	–	–	–	–	1	0·75	1	0·75
Yeovil..	13,439	–	–	75	5·58	21	1·56	–	–	1	0·07	11	0·82
RURAL DISTRICTS:—													
Axbridge	21,615	–	–	24	1·11	46	2·13	9	0·42	–	–	15	0·69
Bath	14,118	–	–	21	1·49	10	0·71	2	0·14	1	0·07	1	0·07
Bridgwater	16,968	–	–	23	1·36	–	–	–	–	1	0·06	7	0·41

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Somerset— *continued.*													
RURAL DISTRICTS:—													
Chard..	12,638	–	–	10	0·79	3	0·24	–	–	–	–	2	0·16
Clutton	15,428	–	–	20	1·30	35	2·27	6	0·39	–	–	8	0·52
Dulverton	4,486	–	–	2	0·45	–	–	2	0·45	–	–	3	0·67
Frome..	10,923	–	–	5	0·46	4	0·37	–	–	–	–	1	0·09
Keynsham	10,218	–	–	54	5·28	8	0·78	–	–	–	–	4	0·39
Langport	12,289	–	–	6	0·49	5	0·41	–	–	–	–	3	0·24
Long Ashton	16,157	–	–	22	1·36	41	2·54	1	0·06	–	–	4	0·25
Shepton Mallet	9,914	–	–	70	7·06	9	0·91	1	0·10	–	–	2	0·20
Taunton	16,332	–	–	24	1·47	39	2·39	6	0·37	–	–	17	1·04
Wellington	5,808	–	–	5	0·86	–	–	2	0·34	–	–	–	–
Wells	8,846	–	–	39	4·41	5	0·57	2	0·23	–	–	8	0·90
Williton	12,091	–	–	19	1·57	3	0·25	–	–	1	0·08	8	0·66
Wincanton	15,231	–	–	18	1·18	20	1·31	–	–	–	–	5	0·33
Yeovil..	15,739	–	–	19	1·21	5	0·32	–	–	–	–	5	0·32
County of Southampton.													
ADMINISTRATIVE COUNTY	395,648	–	–	1046	2·64	633	1·60	48	0·12	14	0·04	177	0·45
COUNTY BOROUGHS:—													
Bournemouth	72,197	–	–	117	1·62	84	1·16	2	0·03	–	–	25	0·35
Portsmouth	202,441	–	–	832	4·11	908	4·49	95	0·47	6	0·03	115	0·57
Southampton	117,349	–	–	426	3·63	346	2·95	25	0·21	5	0·04	58	0·49
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	181,957	–	–	652	3·58	345	1·90	27	0·15	8	0·04	82	0·45
AGGREGATE OF RURAL DISTRICTS.	213,691	–	–	394	1·84	288	1·35	21	0·10	6	0·03	95	0·44
BOROUGHS AND URBAN DISTRICTS:—													
Aldershot	22,051	–	–	182	8·25	59	2·68	2	0·09	–	–	4	0·18
Alton	5,256	–	–	13	2·47	1	0·19	–	–	–	–	1	0·19
Andover	8,097	–	–	4	0·49	4	0·49	–	–	–	–	6	0·74
Basingstoke	12,434	–	–	13	1·05	6	0·48	–	–	–	–	2	0·16
Christchurch	5,561	–	–	16	2·88	10	1·80	1	0·18	2	0·36	1	0·18
Eastleigh and Bishopstoke.	14,638	–	–	29	1·98	14	0·96	–	–	–	–	13	0·89
Fareham	7,624	–	–	22	2·89	17	2·23	4	0·52	–	–	6	0·79
Farnborough	9,728	–	–	51	5·24	5	0·51	1	0·10	–	–	6	0·62
Fleet	3,611	–	–	6	1·66	13	3·60	–	–	–	–	1	0·28
Gosport and Alverstoke..	27,537	–	–	65	2·36	132	4·79	2	0·07	1	0·04	21	0·76
Havant	4,015	–	–	30	7·47	–	–	–	–	–	–	–	–
Itchen..	22,311	–	–	114	5·11	29	1·30	3	0·13	–	–	11	0·49
Lymington	4,100	–	–	2	0·49	5	1·22	1	0·24	–	–	3	0·73
Petersfield	3,735	–	–	5	1·34	4	1·07	–	–	–	–	1	0·27
Romsey	4,698	–	–	6	1·28	4	0·85	–	–	–	–	3	0·64
Warblington	3,769	–	–	18	4·78	1	0·27	5	1·33	–	–	1	0·27
Winchester	22,792	–	–	76	3·33	41	1·80	8	0·35	5	0·22	2	0·09
RURAL DISTRICTS:—													
Alresford	7,172	–	–	3	0·42	8	1·12	–	–	–	–	–	–
Alton	13,259	–	–	35	2·64	15	1·13	–	–	–	–	6	0·45
Andover	10,060	–	–	22	2·19	27	2·68	–	–	–	–	4	0·40
Basingstoke	12,261	–	–	11	0·90	7	0·57	–	–	–	–	–	–
Catherington	3,481	–	–	11	3·16	5	1·44	2	0·57	–	–	–	–
Christchurch	4,818	–	–	3	0·62	–	–	–	–	1	0·21	4	0·83
Droxford	12,202	–	–	20	1·64	9	0·74	2	0·16	1	0·08	9	0·74
Fareham	13,761	–	–	28	2·03	60	4·36	7	0·51	1	0·07	8	0·58
Fordingbridge	6,142	–	–	8	1·30	12	1·95	1	0·16	–	–	8	1·30
Hartley Wintney	18,150	–	–	39	2·15	11	0·61	–	–	2	0·11	6	0·33
Havant	5,559	–	–	9	1·62	6	1·08	4	0·72	–	–	–	–
Hursley	4,257	–	–	29	6·81	1	0·23	–	–	–	–	3	0·70
Kingsclere	8,652	–	–	11	1·27	24	2·77	–	–	–	–	6	0·69
Lymington	11,597	–	–	5	0·43	3	0·26	–	–	–	–	9	0·78
New Forest	16,917	–	–	27	1·60	40	2·36	1	0·06	1	0·06	3	0·18
Petersfield	11,001	–	–	31	2·82	14	1·27	2	0·18	–	–	4	0·36
Ringwood	6,803	–	–	11	1·62	4	0·59	–	–	–	–	5	0·73
Romsey	7,034	–	–	28	3·98	4	0·57	–	–	–	–	1	0·14
South Stoneham	18,481	–	–	42	2·27	29	1·57	1	0·05	–	–	8	0·43
Stockbridge..	6,203	–	–	3	0·48	–	–	–	–	–	–	–	–
Whitchurch..	6,079	–	–	6	0·99	6	0·99	–	–	–	–	7	1·15
Winchester	9,802	–	–	12	1·22	3	0·31	1	0·10	–	–	4	0·41

Notifications of Infectious Disease and Attack-Rates, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate	Cases.	Rate.
County of Isle of Wight.													
Administrative County	79,269	–	–	169	2·13	52	0·66	19	0·24	2	0·03	22	0·28
Aggregate of Boroughs and Urban Districts.	52,642	–	–	107	2·03	37	0·70	17	0·32	2	0·04	17	0·32
Aggregate of Rural Districts.	26,627	–	–	62	2·33	15	0·56	2	0·08	–	–	5	0·19
Boroughs and Urban Districts:—													
Cowes	10,068	–	–	4	0·40	–	–	7	0·70	–	–	1	0·10
East Cowes	4,907	–	–	–	–	–	–	3	0·61	–	–	–	–
Newport	10,881	–	–	55	5·05	12	1·10	1	0·09	1	0·09	7	0·64
Ryde	9,276	–	–	18	1·94	17	1·83	5	0·54	1	0·11	5	0·54
St. Helens	4,567	–	–	10	2·19	2	0·44	–	–	–	–	–	–
Sandown	4,755	–	–	13	2·73	4	0·84	–	–	–	–	3	0·63
Shanklin	4,095	–	–	2	0·49	1	0·24	–	–	–	–	–	–
Ventnor	4,093	–	–	5	1·22	1	0·24	1	0·24	–	–	1	0·24
Rural Districts:—													
Isle of Wight	26,627	–	–	62	2·33	15	0·56	2	0·08	–	–	5	0·19
County of Stafford.													
Administrative County	666,208	1	0·00	2265	3·40	775	1·16	59	0·09	37	0·06	390	0·59
County Boroughs:—													
Burton upon Trent ..	45,786	–	–	100	2·18	44	0·96	1	0·02	2	0·04	38	0·83
Smethwick	72,439	–	–	252	3·48	57	0·79	–	–	9	0·12	48	0·66
Stoke on Trent	225,405	–	–	871	3·86	933	4·14	48	0·21	21	0·09	202	0·90
Walsall	92,045	–	–	236	2·56	68	0·74	8	0·09	5	0·05	81	0·88
West Bromwich	68,402	–	–	108	1·58	54	0·79	1	0·01	6	0·09	34	0·50
Wolverhampton	94,968	–	–	206	2·17	140	1·47	3	0·03	2	0·02	63	0·66
Aggregate of Boroughs and Urban Districts.	462,812	1	0·00	1619	3·50	552	1·19	51	0·11	28	0·06	305	0·66
Aggregate of Rural Districts.	203,396	–	–	646	3·18	223	1·10	8	0·04	9	0·04	85	0·42
Boroughs and Urban Districts:—													
Amblecote	3,091	–	–	17	5·50	4	1·29	–	–	–	–	1	0·32
Audley	14,756	–	–	26	1·76	69	4·68	–	–	–	–	3	0·20
Biddulph	7,773	–	–	58	7·46	5	0·64	–	–	–	–	4	0·51
Bilston	25,229	–	–	50	1·98	10	0·40	1	0·04	–	–	21	0·83
Brierley Hill	12,034	–	–	30	2·49	90	7·48	–	–	2	0·17	7	0·58
Brownhills	17,564	–	–	54	3·07	45	2·56	–	–	–	–	8	0·46
Cannock	30,337	–	–	133	4·38	22	0·73	–	–	5	0·16	19	0·63
Coseley	22,817	–	–	47	2·06	8	0·35	8	0·35	1	0·04	22	0·96
Darlaston	17,384	–	–	13	0·75	5	0·29	1	0·06	–	–	9	0·52
Heath Town	12,174	–	–	24	1·97	7	0·57	2	0·16	–	–	9	0·74
Kidsgrove	8,972	–	–	13	1·45	15	1·67	3	0·33	1	0·11	4	0·45
Leek	17,658	1	0·06	188	10·65	27	1·53	–	–	1	0·06	13	0·74
Lichfield	8,196	–	–	15	1·83	4	0·49	1	0·12	–	–	7	0·85
Newcastle under Lyme..	19,282	–	–	153	7·93	41	2·13	7	0·36	2	0·10	7	0·36
Perry Barr	2,458	–	–	15	6·10	1	0·41	–	–	–	–	3	1·22
Quarry Bank	7,636	–	–	22	2·88	7	0·92	–	–	2	0·26	6	0·79
Rowley Regis	38,274	–	–	99	2·59	16	0·42	8	0·21	1	0·03	24	0·63
Rugeley	4,438	–	–	8	1·80	4	0·90	–	–	–	–	1	0·23
Sedgley	16,459	–	–	32	1·94	24	1·46	1	0·06	2	0·12	17	1·03
Short Heath	4,084	–	–	43	10·53	–	–	–	–	–	–	3	0·73
Smallthorne	13,606	–	–	12	0·88	32	2·35	6	0·44	–	–	16	1·18
Stafford	21,748	–	–	138	6·35	23	1·06	1	0·05	–	–	15	0·69
Stone	5,223	–	–	35	6·70	3	0·57	–	–	–	–	3	0·57
Tamworth	7,311	–	–	2	0·27	1	0·14	–	–	–	–	2	0·27
Tettenhall	5,408	–	–	1	0·18	–	–	–	–	–	–	1	0·18
Tipton	32,005	–	–	31	0·97	21	0·66	7	0·22	2	0·06	30	0·94

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases	Rate.
County of Stafford—*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Uttoxeter	5,203	–	–	6	1·15	5	0·96	–	–	1	0·19	2	0·38
Wednesbury	28,414	–	–	20	0·70	16	0·56	3	0·11	6	0·21	15	0·53
Wednesfield..	6,784	–	–	10	1·47	3	0·44	–	–	–	–	5	0·74
Willenhall	18,880	–	–	72	3·81	1	0·05	–	–	–	–	16	0·85
Wolstanton United ..	27,614	–	–	252	9·13	43	1·56	2	0·07	2	0·07	12	0·43
RURAL DISTRICTS :—													
Blore Heath..	2,204	–	–	29	13·16	–	–	–	–	–	–	–	–
*Blymhill and Weston under Lizard (Parishes).	729	–	–	1	1·37	–	–	–	–	–	–	–	–
Cannock	19,936	–	–	43	2·16	2	0·10	–	–	–	–	9	0·45
Cheadle	25,950	–	–	170	6·55	31	1·19	2	0·08	–	–	23	0·89
Gnosall	4,593	–	–	3	0·65	3	0·65	–	–	–	–	–	–
Kingswinford	20,446	–	–	51	2·49	11	0·54	–	–	–	–	6	0·29
Leek	15,641	–	–	42	2·69	43	2·75	1	0·06	–	–	6	0·38
Lichfield	24,626	–	–	35	1·42	42	1·71	1	0·04	2	0·08	5	0·20
Mayfield	3,957	–	–	14	3·54	–	–	–	–	–	–	1	0·25
Newcastle under Lyme..	6,198	–	–	69	11·13	11	1·77	–	–	1	0·16	4	0·65
Seisdon	15,348	–	–	16	1·04	18	1·17	–	–	2	0·13	10	0·65
Stafford	12,097	–	–	54	4·46	12	0·99	1	0·08	–	–	2	0·17
Stoke upon Trent ..	4,692	–	–	10	2·13	10	2·13	2	0·43	–	–	4	0·85
Stone	13,710	–	–	34	2·48	14	1·02	–	–	1	0·07	2	0·15
†Tamworth (part of) ..	5,124	–	–	–	–	2	0·39	–	–	–	–	2	0·39
Tutbury	8,490	–	–	40	4·71	5	0·59	–	–	3	0·35	2	0·24
Uttoxeter	7,383	–	–	18	2·44	5	0·68	1	0·14	–	–	1	0·14
Walsall	12,272	–	–	17	1·39	14	1·14	–	–	–	–	8	0·65
County of Suffolk, East.													
ADMINISTRATIVE COUNTY	190,909	–	–	587	3·07	197	1·03	48	0·25	9	0·05	77	0·40
COUNTY BOROUGH :—													
Ipswich	74,251	–	–	542	7·30	102	1·37	16	0·22	3	0·04	41	0·55
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	77,273	–	–	177	2·29	129	1·67	26	0·34	6	0·08	42	0·54
AGGREGATE OF RURAL DISTRICTS.	113,636	–	–	410	3·61	68	0·60	22	0·19	3	0·03	35	0·31
BOROUGHS AND URBAN DISTRICTS :—													
Aldeburgh	2,214	–	–	3	1·36	–	–	5	2·26	–	–	1	0·45
Beccles	6.730	–	–	30	4·46	1	0·15	–	–	–	–	1	0·15
Bungay	2,918	–	–	2	0·69	3	1·03	–	–	1	0·34	2	0·69
Eye	1,837	–	–	20	10·89	–	–	–	–	–	–	1	0·54
Felixstowe	8,034	–	–	14	1·74	30	3·73	2	0·25	–	–	5	0·62
Halesworth	2,099	–	–	1	0·48	–	–	–	–	–	–	–	–
Leiston-cum-Sizewell ..	4,189	–	–	22	5·25	1	0·24	1	0·24	2	0·48	5	1·19
Lowestoft	32,646	–	–	47	1·44	65	1·99	17	0·52	1	0·03	16	0·49
Oulton Broad	4,038	–	–	11	2·72	8	1·98	–	–	–	–	2	0·50
Saxmundham	1,392	–	–	5	3·59	–	–	–	–	–	–	–	–
Southwold	2,415	–	–	–	–	1	0·41	–	–	–	–	2	0·83
Stowmarket	4,441	–	–	11	2·48	20	4·50	1	0·23	2	0·45	6	1·35
Woodbridge..	4,320	–	–	11	2·55	–	–	–	–	–	–	1	0·23
RURAL DISTRICTS :—													
Blything	16,887	–	–	17	1·01	11	0·65	1	0·06	2	0·12	3	0·18
Bosmere and Claydon ..	13,513	–	–	89	6·59	19	1·41	1	0·07	–	–	5	0·37
East Stow	6,195	–	–	21	3·39	6	0·97	–	–	–	–	7	1·13
Hartismere	10,982	–	–	27	2·46	2	0·18	–	–	–	–	10	0·91
Hoxne	9,801	–	–	29	2·96	6	0·61	–	–	–	–	1	0·10
Mutford and Lothingland	10,692	–	–	36	3·37	9	0·84	4	0·37	1	0·09	4	0·37
Plomesgate	14,757	–	–	68	4·61	2	0·14	–	–	–	–	3	0·20
Samford	11,924	–	–	60	5·03	1	0·08	–	–	–	–	–	–
Wangford	4,527	–	–	31	6·85	1	0·22	–	–	–	–	2	0·44
Woodbridge..	14,358	–	–	32	2·23	11	0·77	16	1·11	–	–	–	–

* These parishes are administered by the Rural District Council of Shifnal (Salop).
† The remaining part of the Rural District of Tamworth is in the Administrative County of Warwick

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Suffolk, West.													
ADMINISTRATIVE COUNTY	107,772	–	–	303	2·81	124	1·15	3	0·03	1	0·01	41	0·38
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	39,885	–	–	106	2·66	84	2·11	1	0·03	1	0·03	13	0·33
AGGREGATE OF RURAL DISTRICTS.	67,887	–	–	197	2·90	40	0·59	2	0·03	–	–	28	0·41
BOROUGHS AND URBAN DISTRICTS :—													
Bury St. Edmunds ..	15,506	–	–	84	5·42	22	1·42	1	0·06	–	–	6	0·39
Glemsford	1,372	–	–	–	–	1	0·73	–	–	–	–	–	–
Hadleigh	2,919	–	–	1	0·34	1	0·34	–	–	–	–	1	0·34
Haverhill	4,416	–	–	–	–	55	12·45	–	–	1	0·23	3	0·68
Newmarket	9,178	–	–	4	0·44	3	0·33	–	–	–	–	1	0·11
Sudbury	6,494	–	–	17	2·62	2	0·31	–	–	–	–	2	0·31
RURAL DISTRICTS :—													
Brandon	5,606	–	–	27	4·82	5	0·89	–	–	–	–	–	–
Clare	7,649	–	–	3	0·39	10	1·31	–	–	–	–	2	0·26
Cosford	10,644	–	–	24	2·25	4	0·38	–	–	–	–	7	0·66
Melford	11,818	–	–	26	2·20	6	0·51	1	0·08	–	–	5	0·42
Mildenhall	7,945	–	–	37	4·66	3	0·38	1	0·13	–	–	7	0·88
Moulton	2,200	–	–	3	1·36	–	–	–	–	–	–	–	–
Thedwastre	8,278	–	–	40	4·83	7	0·85	–	–	–	–	4	0·48
Thingoe	13,747	–	–	37	2·69	5	0·36	–	–	–	–	3	0·22
County of Surrey.													
ADMINISTRATIVE COUNTY	662,282	–	–	2063	3·11	819	1·24	103	0·16	36	0·05	297	0·45
COUNTY BOROUGH :— Croydon	177,345	–	–	407	2·29	191	1·08	21	0·12	12	0·07	81	0·46
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	514,246	–	–	1571	3·15	639	1·28	93	0·19	30	0·06	228	0·46
AGGREGATE OF RURAL DISTRICTS.	148,036	–	–	492	3·00	180	1·10	10	0·06	6	0·04	69	0·42
BOROUGHS AND URBAN DISTRICTS :—													
Barnes	32,288	–	–	137	4·24	42	1·30	3	0·09	6	0·19	10	0·31
*Beddington and Wallington.	15,334	–	–	39	3·35	14	1·20	1	0·09	–	–	6	0·52
Carshalton	12,397	–	–	36	2·90	19	1·53	1	0·08	1	0·08	3	0·24
Caterham	7,596	–	–	9	1·18	6	0·79	–	–	–	–	6	0·79
Chertsey	13,297	–	–	33	2·48	17	1·28	3	0·23	–	–	5	0·38
*Coulsdon and Purley ..	17,920	–	–	28	2·06	7	0·51	27	1·99	–	–	8	0·59
Dorking	7,088	–	–	66	9·31	9	1·27	–	–	1	0·14	1	0·14
East and West Molesey ..	6,564	–	–	22	3·35	5	0·76	–	–	2	0·30	3	0·46
Egham	11,721	–	–	37	3·16	9	0·77	5	0·43	–	–	8	0·68
Epsom	11,927	–	–	39	3·27	17	1·43	7	0·59	–	–	15	1·26
Esher and the Dittons ..	12,911	–	–	8	0·62	27	2·09	2	0·15	1	0·08	2	0·15
Farnham	11,880	–	–	26	2·19	32	2·69	–	–	–	–	2	0·17
Frimley	10,207	–	–	44	4·31	1	0·10	–	–	–	–	–	–
Godalming	8,292	–	–	124	14·95	1	0·12	–	–	–	–	1	0·12
Guildford	23,681	–	–	56	2·36	22	0·93	–	–	2	0·08	7	0·30
Ham	1,180	–	–	9	7·63	1	0·85	–	–	–	–	2	1·69
Haslemere	3,928	–	–	17	4·33	2	0·51	–	–	1	0·25	2	0·51
Kingston upon Thames ..	36,375	–	–	55	1·51	16	0·44	10	0·27	6	0·16	33	0·91
Leatherhead	5,128	–	–	7	1·37	9	1·76	–	–	–	–	2	0·39
Merton and Morden ..	16,196	–	–	53	3·27	24	1·48	5	0·31	–	–	6	0·37
*Mitcham	33,408	–	–	100	3·94	65	2·56	3	0·12	–	–	18	0·71
Reigate	26,838	–	–	178	6·63	24	0·89	1	0·04	1	0·04	12	0·45
Richmond	33,730	–	–	123	3·65	40	1·19	4	0·12	1	0·03	9	0·27
Surbiton	17,426	–	–	33	1·89	27	1·55	1	0·06	1	0·06	5	0·29
Sutton	20,012	–	–	31	1·55	16	0·80	–	–	2	0·10	5	0·25
The Maldens and Coombe	13,806	–	–	43	3·11	33	2·39	1	0·07	–	–	17	1·23
Walton upon Thames ..	13,072	–	–	3	0·23	10	0·76	–	–	–	–	1	0·08
Weybridge	6,278	–	–	5	0·80	13	2·07	–	–	1	0·16	–	–
Wimbledon	56,409	–	–	184	3·26	117	2·07	13	0·23	2	0·04	28	0·50
Windlesham	4,214	–	–	7	1·66	2	0·47	–	–	1	0·24	–	–
Woking	23,143	–	–	19	0·82	12	0·52	6	0·26	1	0·04	11	0·48
RURAL DISTRICTS :—													
Chertsey	9,925	–	–	10	1·01	18	1·81	–	–	1	0·10	2	0·20
*Croydon	67,726†	–	–	72	4·41	34	2·08	2	0·12	2	0·12	18	1·10
Dorking	10,316	–	–	33	3·20	11	1·07	–	–	–	–	3	0·29

* On 1st April, 1915, the Rural District of Croydon was abolished. Part of its area was added to the Rural Districts of Godstone and Epsom and the remainder constituted the Urban Districts of Coulsdon and Purley, Beddington and Wallington, and Mitcham. Allowance has been made in the calculation of rates.

† Excluded from population of Aggregate of Rural Districts shewn above.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Surrey—*continued.*													
RURAL DISTRICTS:—													
*Epsom	28,537	–	–	50	1·76	41	1·44	1	0·04	1	0·04	15	0·53
Farnham	16,656	–	–	65	3·90	22	1·32	1	0·06	–	–	3	0·18
*Godstone	22,463	–	–	78	3·49	13	0·58	–	–	–	–	11	0·49
Guildford	18,271	–	–	62	3·39	4	0·22	3	0·16	–	–	1	0·05
Hambledon	22,114	–	–	66	2·98	26	1·18	1	0·05	2	0·09	3	0·14
Reigate	19,754	–	–	56	2·83	11	0·56	2	0·10	–	–	13	0·66
County of Sussex, East.													
ADMINISTRATIVE COUNTY	226,746	–	–	360	1·59	179	0·79	15	0·07	9	0·04	79	0·35
COUNTY BOROUGHS:—													
Brighton	118,286	–	–	219	1·85	120	1·01	18	0·15	2	0·02	61	0·52
Eastbourne	47,125	–	–	175	3·71	144	3·06	5	0·11	5	0·11	16	0·34
Hastings	52,053	–	–	97	1·86	89	1·71	1	0·02	3	0·06	26	0·50
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	109,390	–	–	181	1·65	114	1·04	8	0·07	8	0·07	42	0·38
AGGREGATE OF RURAL DISTRICTS.	117,356	–	–	179	1·53	65	0·55	7	0·06	1	0·01	37	0·32
BOROUGHS AND URBAN DISTRICTS:—													
Battle	2,763	–	–	1	0·36	1	0·36	–	–	–	–	–	–
Bexhill	14,546	–	–	17	1·17	23	1·58	4	0·27	–	–	3	0·21
Burgess Hill	4,960	–	–	2	0·40	20	4·03	–	–	–	–	1	0·20
Cuckfield	1,820	–	–	6	3·30	–	–	–	–	–	–	–	–
East Grinstead	6,904	–	–	2	0·29	8	1·16	–	–	–	–	–	–
Haywards Heath	4,715	–	–	25	5·30	6	1·27	–	–	1	0·21	4	0·85
Hove	38,741	–	–	46	1·19	19	0·49	2	0·05	4	0·10	24	0·62
Lewes	10,243	–	–	28	2·73	3	0·29	2	0·20	–	–	5	0·49
Newhaven	6,511	–	–	6	0·92	27	4·15	–	–	2	0·31	4	0·61
Portslade by Sea	6,593	–	–	17	2·58	3	0·46	–	–	1	0·15	1	0·15
Rye	3,8 6	–	–	5	1·29	–	–	–	–	–	–	–	–
Seaford	4,624	–	–	20	4·33	2	0·43	–	–	–	–	–	–
Uckfield	3,104	–	–	6	1·93	2	0·64	–	–	–	–	–	–
RURAL DISTRICTS:—													
Battle	6,007	–	–	4	0·67	–	–	–	–	–	–	1	0·17
Chailey	10,699	–	–	6	0·56	9	0·84	2	0·19	–	–	9	0·84
Cuckfield	15,911	–	–	8	0·50	7	0·44	–	–	–	–	3	0·19
Eastbourne	5,075	–	–	21	4·14	3	0·59	2	0·39	–	–	3	0·59
East Grinstead	12,631	–	–	32	2·53	6	0·48	–	–	–	–	4	0·32
Hailsham	15,835	–	–	47	2·97	12	0·76	1	0·06	–	–	4	0·25
Hastings	1,514	–	–	–	–	–	–	–	–	–	–	1	0·66
Newhaven	4,328	–	–	3	0·69	3	0·69	1	0·23	–	–	–	–
Rye	6,640	–	–	8	1·20	2	0·30	–	–	–	–	2	0·30
Steyning East	2,661	–	–	–	–	2	0·75	–	–	–	–	2	0·75
Ticehurst	13,041	–	–	26	1·99	1	0·08	–	–	1	0·08	2	0·15
Uckfield	23,014	–	–	24	1·04	20	0·87	1	0·04	–	–	6	0·26
County of Sussex, West.													
ADMINISTRATIVE COUNTY	164,207	–	–	395	2·41	267	1·63	24	0·15	4	0·02	58	0·35
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	77,418	–	–	197	2·54	151	1·95	4	0·05	2	0·03	32	0·41
AGGREGATE OF RURAL DISTRICTS.	86,789	–	–	198	2·28	116	1·34	20	0·23	2	0·02	26	0·30
BOROUGHS AND URBAN DISTRICTS:—													
Arundel	2,528	–	–	3	1·19	4	1·58	–	–	–	–	1	0·40
Bognor	7,673	–	–	15	1·95	24	3·13	–	–	–	–	3	0·39

* On 1st April, 1915, the Rural District of Croydon was abolished. Part of its area was added to the Rural Districts of Godstone and Epsom and the remainder constituted the Urban Districts of Coulsdon and Purley, Beddington and Wallington, and Mitcham. Allowance has been made in the calculation of rates.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Sussex, West—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Chichester	10,240	-	-	63	6·15	17	1·66	-	-	-	-	5	0·49
Horsham	10,635	-	-	10	0·94	1	0·09	-	-	-	-	2	0·19
Littlehampton	8,015	-	-	30	3·74	21	2·62	2	0·25	-	-	3	0·37
Shoreham by Sea	5,599	-	-	8	1·43	17	3·04	1	0·18	-	-	7	1·25
Southwick	4,576	-	-	2	0·44	5	1·09	-	-	1	0·22	5	1·09
Worthing	28,152	-	-	66	2·34	62	2·20	1	0·04	1	0·04	6	0·21
RURAL DISTRICTS:—													
East Preston	6,550	-	-	10	1·53	10	1·53	1	0·15	-	-	1	0·15
Horsham	20,004	-	-	70	3·50	6	0·30	2	0·10	-	-	4	0·20
Midhurst	13,953	-	-	25	1·79	15	1·08	5	0·36	-	-	6	0·43
Petworth	8,287	-	-	14	1·69	20	2·41	-	-	-	-	4	0·48
Thakeham	7,805	-	-	3	0·38	7	0·90	-	-	-	-	7	0·90
Westbourne	8,100	-	-	12	1·48	6	0·74	7	0·86	-	-	-	-
West Hampnett	13,917	-	-	57	4·10	18	1·29	4	0·29	1	0·07	-	-
West Steyning	8,173	-	-	7	0·86	34	4·16	1	0·12	1	0·12	4	0·49
County of Warwick.													
ADMINISTRATIVE COUNTY.	308,012	2	0·01	1,039	3·37	203	0·66	29	0·09	21	0·07	158	0·51
COUNTY BOROUGHS:—													
Birmingham	864,545	-	-	3,141	3·63	1,237	1·43	37	0·04	157	0·18	735	0·85
Coventry	120,529	-	-	654	5·43	209	1·73	7	0·06	7	0·06	89	0·74
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	136,672	2	0·01	428	3·13	100	0·73	11	0·08	9	0·07	77	0·56
AGGREGATE OF RURAL DISTRICTS.	171,340	-	-	611	3·57	103	0·60	18	0·11	12	0·07	81	0·47
BOROUGHS AND URBAN DISTRICTS:—													
Bulkington	2,048	-	-	-	-	1	0·49	-	-	-	-	-	-
Kenilworth	5,885	-	-	8	1·36	3	0·51	3	0·51	-	-	3	0·51
Nuneaton	38,652	-	-	83	2·15	12	0·31	-	-	2	0·05	16	0·41
Royal Leamington Spa ..	25,912	-	-	42	1·62	27	1·04	3	0·12	-	-	13	0·50
Rugby	23,083	1	0·04	149	6·45	17	0·74	3	0·13	4	0·17	20	0·87
Stratford-on-Avon ..	8,224	-	-	33	4·01	3	0·36	-	-	1	0·12	5	0·61
Sutton Coldfield	21,589	-	-	78	3·61	13	0·60	1	0·05	2	0·09	3	0·14
Warwick	11,279	1	0·09	35	3·11	24	2·13	1	0·09	-	-	17	1·51
RURAL DISTRICTS:—													
Alcester	11,552	-	-	20	1·73	12	1·04	1	0·09	-	-	6	0·52
Atherstone	19,710	-	-	69	3·50	2	0·10	2	0·10	1	0·05	5	0·25
Brailes	5,709	-	-	10	1·75	4	0·70	-	-	-	-	-	-
Coventry	2,166	-	-	5	2·31	3	1·39	-	-	-	-	-	-
Farnborough	1,349	-	-	2	1·48	-	-	-	-	-	-	-	-
Foleshill	27,331	-	-	65	2·38	10	0·37	1	0·04	4	0·15	7	0·26
Meriden	15,332	-	-	92	6·00	6	0·39	-	-	1	0·07	13	0·85
Monks Kirby	1,452	-	-	11	7·58	-	-	-	-	-	-	4	2·75
Nuneaton	2,882	-	-	4	1·39	4	1·39	-	-	-	-	3	1·04
Rugby	18,382	-	-	126	6·85	13	0·71	-	-	1	0·05	11	0·60
Solihull	19,306	-	-	41	2·12	11	0·57	1	0·05	1	0·05	8	0·41
Southam	9,370	-	-	69	7·36	15	1·60	13	1·39	2	0·21	12	1·28
Stratford-on-Avon ..	10,373	-	-	54	5·21	6	0·58	-	-	-	-	-	-
*Tamworth (part of) ..	16,051	-	-	16	1·00	8	0·50	-	-	1	0·06	11	0·69
Warwick	10,375	-	-	27	2·60	9	0·87	-	-	1	0·10	1	0·10

* The remaining part of the Rural District of Tamworth is in the Administrative County of Stafford. The figures for the entire district are:—

21,175	-	-	16	0·76	10	0·47	-	-	1	0·05	13	0·61

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Westmorland.													
ADMINISTRATIVE COUNTY	60,741	–	–	109	1·79	24	0·40	32	0·53	3	0·05	34	0·56
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	25,604	–	–	40	1·56	11	0·43	25	0·98	1	0·04	16	0·62
AGGREGATE OF RURAL DISTRICTS.	35,137	–	–	69	1·96	13	0·37	7	0·20	2	0·06	18	0·51
BOROUGHS AND URBAN DISTRICTS:–													
Ambleside	2,230	–	–	5	2·24	–	–	–	–	–	–	3	1·35
Appleby	1,702	–	–	8	4·70	1	0·59	–	–	–	–	2	1·18
Grasmere	770	–	–	–	–	–	–	–	–	–	–	–	–
Kendal	13,194	–	–	22	1·67	7	0·53	24	1·82	1	0·08	8	0·61
Kirkby Lonsdale	1,377	–	–	–	–	–	–	1	0·73	–	–	3	2·18
Shap	950	–	–	4	4·21	2	2·11	–	–	–	–	–	–
Windermere	5,381	–	–	1	0·19	1	0·19	–	–	–	–	–	–
RURAL DISTRICTS:—													
East Westmorland ..	10,980	–	–	32	2·91	2	0·18	–	–	1	0·09	5	0·46
South Westmorland ..	17,909	–	–	33	1·84	8	0·45	7	0·39	1	0·06	9	0·50
West Ward	6,248	–	–	4	0·64	3	0·48	–	–	–	–	4	0·64
County of Wilts.													
ADMINISTRATIVE COUNTY	280,519	–	–	1,274	4·54	434	1·55	25	0·09	11	0·04	126	0·45
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	126,356	–	–	796	6·30	297	2·35	14	0·11	6	0·05	84	0·66
AGGREGATE OF RURAL DISTRICTS.	154,163	–	–	478	3·10	137	0·89	11	0·07	5	0·03	42	0·27
BOROUGHS AND URBAN DISTRICTS:—													
Bradford on Avon ..	4,402	–	–	12	2·73	3	0·68	1	0·23	–	–	3	0·68
Calne	3,468	–	–	29	8·36	1	0·29	–	–	–	–	2	0·58
Chippenham	7,439	–	–	12	1·61	75	10·08	3	0·40	–	–	3	0·40
Devizes	6,128	–	–	62	10·12	79	12·89	–	–	–	–	–	–
Malmesbury	2,441	–	–	2	0·82	–	–	–	–	–	–	–	–
Marlborough	3,680	–	–	–	–	6	1·63	–	–	–	–	1	0·27
Melksham	3,424	–	–	6	1·75	2	0·58	–	–	–	–	3	0·88
Salisbury	20,958	–	–	98	4·68	37	1·77	3	0·14	1	0·05	14	0·67
Swindon	51,647	–	–	440	8·52	67	1·30	4	0·08	2	0·04	47	0·91
Trowbridge	11,654	–	–	36	3·09	1	0·09	3	0·26	1	0·09	2	0·17
Warminster	5,480	–	–	60	10·95	25	4·56	–	–	–	–	3	0·55
Westbury	3,454	–	–	4	1·16	1	0·29	–	–	–	–	2	0·58
Wilton	2,181	–	–	35	16·05	–	–	–	–	2	0·92	4	1·83
RURAL DISTRICTS:—													
Amesbury	13,031	–	–	16	1·23	5	0·38	2	0·15	–	–	–	–
Bradford on Avon ..	5,178	–	–	6	1·16	1	0·19	–	–	–	–	2	0·39
Calne	4,316	–	–	23	5·33	–	–	–	–	–	–	1	0·23
Chippenham	14,733	–	–	73	4·95	8	0·54	6	0·41	–	–	4	0·27
Cricklade and Wootton Bassett.	10,282	–	–	14	1·36	6	0·58	1	0·10	–	–	3	0·29
Devizes	10,759	–	–	74	6·88	47	4·37	1	0·09	1	0·09	6	0·56
Highworth	14,505	–	–	77	5·31	13	0·90	–	–	–	–	9	0·62
Malmesbury	8,890	–	–	21	2·36	–	–	–	–	–	–	3	0·34
Marlborough	4,195	–	–	1	0·24	18	4·29	–	–	–	–	–	–
Melksham	4,634	–	–	14	3·02	3	0·65	–	–	–	–	–	–
Mere	4,830	–	–	8	1·66	1	0·21	–	–	–	–	1	0·21
Pewsey	12,338	–	–	52	4·21	7	0·57	–	–	–	–	–	–
Ramsbury	6,705	–	–	–	–	4	0·60	–	–	–	–	2	0·30
Salisbury	9,964	–	–	19	1·91	4	0·40	–	–	–	–	3	0·30
*Tetbury (part of) ..	330	–	–	–	–	1	3·03	–	–	–	–	–	–
Tisbury	7,487	–	–	8	1·07	2	0·27	–	–	–	–	–	–
Warminster	6,281	–	–	9	1·43	10	1·59	1	0·16	3	0·48	1	0·16
Westbury and Whorwellsdown.	6,403	–	–	16	2·50	3	0·47	–	–	–	–	1	0·16
Wilton	9,302	–	–	47	5·05	4	0·43	–	–	1	0·11	6	0·65

* The remaining part of the Rural District of Tetbury is in the Administrative County of Gloucester.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Worcester.													
ADMINISTRATIVE COUNTY	280,212	–	–	1013	3·62	350	1·25	20	0·07	13	0·05	153	0·55
COUNTY BOROUGHS:—													
Dudley (including Dudley Castle Hill).	50,849	–	–	242	4·76	3	0·06	3	0·06	1	0·02	43	0·85
Worcester	46,071	–	–	83	1·80	75	1·63	6	0·13	4	0·09	23	0·50
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	153,235	–	–	682	4·45	203	1·32	7	0·05	8	0·05	97	0·63
AGGREGATE OF RURAL DISTRICTS.	126,977	–	–	331	2·61	147	1·16	13	0·10	5	0·04	56	0·44
BOROUGHS AND URBAN DISTRICTS:—													
Bewdley	2,536	–	–	3	1·18	6	2·37	–	–	–	–	2	0·79
Bromsgrove..	8,495	–	–	12	1·41	6	0·71	–	–	–	–	–	–
Droitwich	3,639	–	–	33	9·07	4	1·10	1	0·27	–	–	–	–
Evesham	8,050	–	–	149	18·51	2	0·25	1	0·12	–	–	7	0·87
Kidderminster	25,198	–	–	37	1·47	16	0·63	–	–	–	–	13	0·52
Lye and Wollescote ..	11,905	–	–	44	3·70	19	1·60	–	–	–	–	14	1·18
Malvern	14,362	–	–	109	7·59	9	0·63	–	–	4	0·28	5	0·35
North Bromsgrove ..	6,763	–	–	1	0·15	5	0·74	–	–	–	–	1	0·15
Oldbury	35,228	–	–	157	4·46	27	0·77	2	0·06	2	0·06	35	0·99
Redditch	15,955	–	–	42	2·63	80	5·01	1	0·06	1	0·06	13	0·81
Stourbridge..	16,857	–	–	92	5·46	17	1·01	1	0·06	1	0·06	5	0·30
Stourport	4,247	–	–	3	0·71	12	2·83	1	0·24	–	–	2	0·47
RURAL DISTRICTS:—													
Bromsgrove..	15,211	–	–	48	3·16	17	1·12	1	0·07	–	–	3	0·20
Droitwich	11,822	–	–	16	1·35	7	0·59	5	0·42	–	–	3	0·25
Evesham	9,054	–	–	64	7·07	8	0·88	–	–	1	0·11	9	0·99
Feckenham..	5,373	–	–	5	0·93	11	2·05	–	–	1	0·19	–	–
Halesowen	27,389	–	–	103	3·76	26	0·95	2	0·07	–	–	15	0·55
Kidderminster	7,030	–	–	15	2·13	12	1·71	–	–	–	–	3	0·43
Martley	12,139	–	–	24	1·98	11	0·91	1	0·08	1	0·08	2	0·16
Pershore	12,650	–	–	26	2·06	3	0·24	–	–	–	–	7	0·55
*Redmarley d'Abitôt and Staunton (parishes).	1,148	–	–	2	1·74	–	–	–	–	–	–	–	–
Rock	2,127	–	–	–	–	1	0·47	–	–	–	–	–	–
Shipston on Stour.. ..	4,164	–	–	4	0·96	41	9·85	–	–	1	0·24	2	0·48
†Stow on the Wold (part of).	288	–	–	–	–	–	–	–	–	–	–	–	–
Tenbury	4,569	–	–	10	2·19	1	0·22	1	0·22	1	0·22	1	0·22
†Tewkesbury (part of) ..	2,125	–	–	1	0·47	5	2·35	–	–	–	–	1	0·47
Upton upon Severn ..	11,780	–	–	13	1·10	4	0·34	3	0·25	–	–	10	0·85
†Winchcomb (part of) ..	108	–	–	–	–	–	–	–	–	–	–	–	–
County of Yorkshire, East Riding.													
ADMINISTRATIVE COUNTY	150,176	–	–	271	1·80	147	0·98	20	0·13	4	0·03	101	0·67
COUNTY BOROUGHS:—													
Kingston upon Hull ..	269,530	–	–	574	2·13	649	2·41	91	0·34	19	0·07	184	0·68
York	79,802	–	–	246	3·08	104	1·30	14	0·18	6	0·08	30	0·38
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	59,509	–	–	83	1·39	71	1·19	14	0·24	1	0·02	41	0·69
AGGREGATE OF RURAL DISTRICTS.	90,667	–	–	188	2·07	76	0·84	6	0·07	3	0·03	60	0·66

* These Parishes are administered by the Rural District Council of Newent (Glos.).
† The remaining parts of the Rural Districts of Stow-on-the-Wold, Tewkesbury, and Winchcomb are in the Administrative County of Gloucester.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Yorkshire, East Riding—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Beverley	13,265	–	–	41	3·09	6	0·45	–	–	–		17	1·28
Bridlington	13,868	–	–	14	1·01	4	0·29	3	0·22	–		4	0·29
Cottingham..	4,815	–	–	10	2·08	4	0·83	–	–	–	–	9	1·87
Filey	3,099	–	–	–	–	1	0·32	–	–	–	–	4	1·29
Great Driffield	5,563	–	–	–	–	4	0·72	10	1·80	1	0·18	2	0·36
Hedon..	1,241	–	–	2	1·61	–	–	–	–	–	–	–	–
Hessle..	5,553	–	–	2	0·36	3	0·54	–	–	–	–	–	–
Hornsea	3,249	–	–	1	0·31	3	0·92	–	–	–	–	1	0·31
Norton	3,741	–	–	3	0·80	46	12·30	–	–	–	–	2	0·53
Pocklington..	2,520	–	–	6	2·38	–	–	–	–	–	–	1	0·40
Withernsea	2,595	–	–	4	1·54	–	–	1	0·39	–	–	1	0·39
RURAL DISTRICTS:—													
Beverley	10,336	–	–	8	1·77	6	0·58	1	0·10	–	–	9	0·87
Bridlington	7,588	–	–	18	2·37	4	0·53	–	–	–	–	3	0·40
Driffield	11,453	–	–	29	2·53	9	0·79	–	–	–	–	2	0·17
Escrick	5,209	–	–	15	2·88	3	0·58	1	0·19	–	–	1	0·19
Howden	11,812	–	–	21	1·78	20	1·69	1	0·08	1	0·08	6	0·51
Norton	5,385	–	–	8	1·49	4	0·74	–	–	–	–	1	0·19
Patrington	6,747	–	–	15	2·22	5	0·74	2	0·30	–	–	26	3·85
Pocklington..	10,620	–	–	25	2·35	–	–	–	–	2	0·19	2	0·19
Riccall	4,062	–	–	6	1·48	2	0·49	1	0·25	–	–	1	0·25
Sculcoates	8,595	–	–	15	1·75	19	2·21	–	–	–	–	2	0·23
Sherburn	2,022	–	–	2	0·99	–	–	–	–	–	–	–	–
Skirlaugh	6,838	–	–	26	3·80	4	0·58	–	–	–	–	7	1·02
County of Yorkshire, North Riding.													
ADMINISTRATIVE COUNTY	285,614	–	–	735	2·57	383	1·34	54	0·19	5	0·02	149	0·52
COUNTY BOROUGH:— Middlesbrough	116,901	–	–	328	2·81	259	2·22	16	0·14	3	0·03	58	0·50
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	154,923	–	–	388	2·50	239	1·54	24	0·15	3	0·02	85	0·55
AGGREGATE OF RURAL DISTRICTS.	130,691	–	–	347	2·66	144	1·10	30	0·23	2	0·02	64	0·49
BOROUGHS AND URBAN DISTRICTS:—													
*Eston	27,660	–	–	55	2·30	24	1·00	3	0·13	1	0·04	12	0·50
Guisborough	6,458	–	–	21	3·25	23	3·56	1	0·15	–	–	6	0·93
Hinderwell	2,406	–	–	–	–	1	0·42	–	–	–	–	–	–
Kirklington cum Upsland	259	–	–	–	–	–	–	–	–	–	–	–	–
Loftus..	8,355	–	–	14	1·68	5	0·60	–	–	1	0·12	2	0·24
Malton	4,448	–	–	10	2·25	22	4·95	1	0·22	–	–	5	1·12
Masham	2,348	–	–	3	1·28	9	3·83	–	–	–	–	3	1·28
Northallerton	4,434	–	–	4	0·90	2	0·45	3	0·68	–	–	2	0·45
Pickering	3,525	–	–	1	0·28	2	0·57	–	–	–	–	2	0·57
Redcar	10,517	–	–	11	1·05	21	2·00	1	0·10	–	–	3	0·29
Richmond	3,456	–	–	42	12·15	22	6·37	–	–	–	–	8	2·31
Saltburn by the Sea ..	3,186	–	–	1	0·31	1	0·31	2	0·63	–	–	1	0·31
Scalby	1,276	–	–	–	–	–	–	–	–	–	–	2	1·57
Scarborough	32,630	–	–	107	3·28	56	1·72	4	0·12	1	0·03	13	0·40
Skelton and Brotton ..	15,116	–	–	33	2·18	15	0·99	–	–	–	–	10	0·66
*South Bank in Normanby	15,341†	–	–	10	2·70	3	0·81	–	–	–	–	2	0·54
Thornaby on Tees ..	18,487	–	–	62	3·35	27	1·46	7	0·38	–	–	9	0·49
Whitby	10,562	–	–	14	1·35	6	0·58	2	0·19	–	–	5	0·48
RURAL DISTRICTS:—													
Aysgarth	4,261	–	–	8	1·88	3	0·70	1	0·23	–	–	2	0·47
Bedale	6,593	–	–	6	0·91	28	4·25	17	2·58	–	–	3	0·46
Croft	2,211	–	–	6	2·71	2	0·90	1	0·45	–	–	–	–
Easingwold	9,956	–	–	23	2·31	3	0·30	–	–	–	–	3	0·30
Flaxton	7,411	–	–	17	2·29	5	0·67	3	0·40	–	–	4	0·54
Guisborough	7,248	–	–	29	4·00	13	1·79	–	–	–	–	3	0·41
Helmsley	4,747	–	–	6	1·26	–	–	–	–	–	–	2	0·42

* On 1st April, 1915, the Urban District of Eston was extended to include the Urban District of South Bank in Normanby. Allowance has been made in the calculation of rates.
† Excluded from the population of the Aggregate of Boroughs and Urban Districts.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Yorkshire, North Riding—*continued.*													
RURAL DISTRICTS :—													
Kirkby Moorside	4,721	–	–	23	4·87	1	0·21	–	–	–	–	9	1·91
Leyburn	6,105	–	–	4	0·66	2	0·33	–	–	–	–	–	–
Malton	5,640	–	–	31	5·50	6	1·06	–	–	–	–	2	0·35
Middlesbrough	2,170	–	–	4	1·84	3	1·38	–	–	–	–	–	–
Northallerton	7,304	–	–	–	–	3	0·41	–	–	–	–	1	0·14
Pickering	6,409	–	–	2	0·31	2	0·31	2	0·31	–	–	2	0·31
Reeth	2,405	–	–	21	8·73	–	–	–	–	2	0·83	17	7·07
Richmond	7,685	–	–	27	3·51	10	1·30	–	–	–	–	3	0·39
Scarborough	6,286	–	–	63	10·02	12	1·91	–	–	–	–	1	0·16
Startforth	4,677	–	–	1	0·21	3	0·64	1	0·21	–	–	–	–
Stokesley	11,893	–	–	23	1·93	40	3·36	2	0·17	–	–	5	0·42
Thirsk	12,400	–	–	42	3·39	6	0·48	2	0·16	–	–	7	0·56
Wath	2,069	–	–	2	0·97	1	0·48	–	–	–	–	–	–
Whitby	8,500	–	–	9	1·06	1	0·12	1	0·12	–	–	–	–
County of Yorkshire, West Riding.													
ADMINISTRATIVE COUNTY	1,442,652	2	0·00	4,541	3·15	1,996	1·38	511	0·35	69	0·05	945	0·66
COUNTY BOROUGHS :—													
Barnsley	50,409	–	–	153	3·04	43	0·85	7	0·14	3	0·06	48	0·95
Bradford	280,737	–	–	497	1·77	424	1·51	96	0·34	30	0·11	237	0·84
Dewsbury	53,299	3	0·06	195	3·66	18	0·34	8	0·15	4	0·08	26	0·49
Halifax	99,497	–	–	264	2·65	87	0·87	26	0·26	2	0·02	58	0·58
Huddersfield	111,139	–	–	373	3·36	173	1·56	8	0·07	2	0·02	57	0·51
Leeds	446,349	1	0·00	1,441	3·23	396	0·89	108	0·24	21	0·05	347	0·78
Rotherham	64,324	–	–	337	5·24	85	1·32	32	0·50	8	0·12	47	0·73
Sheffield	476,012	–	–	2,172	4·56	1,020	2·14	63	0·13	63	0·13	391	0·82
Wakefield	48,407	–	–	51	1·05	93	1·92	16	0·33	4	0·08	26	0·54
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	1,072,190	2	0·00	3,137	2·93	1,657	1·55	381	0·36	51	0·05	741	0·69
AGGREGATE OF RURAL DISTRICTS.	370,462	–	–	1,404	3·76	339	0·91	130	0·35	18	0·05	204	0·55
BOROUGHS AND URBAN DISTRICTS :—													
*Adwick le Street	10,431	–	–	27	3·41	9	1·14	4	0·51	–	–	1	0·13
Altofts	4,799	–	–	46	9·59	2	0·42	1	0·21	1	0·21	6	1·25
Ardsley	6,921	–	–	37	5·35	11	1·59	2	0·29	–	–	5	0·72
Ardsley East and West	8,642	–	–	5	0·58	8	0·93	3	0·35	–	–	8	0·93
Baildon	6,427	–	–	14	2·18	2	0·31	–	–	–	–	3	0·47
Barkisland	1,572	–	–	2	1·27	1	0·64	–	–	–	–	–	–
Barnoldswick	12,099	–	–	26	2·15	2	0·17	–	–	1	0·08	20	1·65
Batley	36,355	–	–	118	3·25	98	2·70	14	0·39	–	–	16	0·44
Bentley with Arksey	11,134	–	–	44	3·95	15	1·35	1	0·09	1	0·09	3	0·27
Bingley	18,714	–	–	22	1·18	26	1·39	7	0·37	–	–	13	0·69
Birkenshaw	2,627	–	–	4	1·52	2	0·76	–	–	–	..	1	0·38
Birstal	7,240	–	–	13	1·80	16	2·21	5	0·69	1	0·14	10	1·38
Bolton upon Dearne	9,760	–	–	53	5·43	74	7·58	14	1·43	3	0·31	10	1·02
Brighouse	20,170	–	–	58	2·88	99	4·91	2	0·10	2	0·10	16	0·79
Burley in Wharfedale	3,414	–	–	50	14·65	2	0·59	3	0·88	–	–	5	1·46
Calverley	3,424	–	–	6	1·75	14	4·09	–	–	–	–	2	0·58
Castleford	23,102	–	–	87	3·77	4	0·17	15	0·65	–	–	16	0·69
Clayton	4,784	–	–	5	1·05	11	2·30	4	0·84	1	0·21	2	0·42
Clayton West	1,879	–	–	–	–	–	–	–	–	–	–	1	0·53
†Cleckheaton	12,984§	–	–	8	2·56	5	1·60	–	–	–	–	1	0·32
Cudworth	6,976	–	–	18	2·58	37	5·30	2	0·29	1	0·14	9	1·29
Darfield	5,452	–	–	74	13·57	–	–	–	–	–	–	5	0·92
Darton	10,405	–	–	54	5·19	10	0·96	4	0·38	1	0·10	8	0·77
‡Denby and Cumberworth	3,791	–	–	3	0·79	–	–	–	–	–	–	1	0·26
Denholme	2,948	–	–	–	–	1	0·34	–	–	–	–	2	0·68
Dodworth	3,234	–	–	9	2·78	–	–	–	–	4	1·24	–	–
Doncaster	50,960	–	–	231	4·53	84	1·65	16	0·31	6	0·12	42	0·82
Drighlington	4,176	–	–	1	0·24	5	1·20	4	0·96	–	–	2	0·48
Earby	6,020	–	–	11	1·83	11	1·83	1	0·17	–	–	6	1·00
Elland	10,959	–	–	24	2·19	10	0·91	2	0·18	–	–	10	0·91
Emley	1,630	–	–	7	4·29	–	–	1	0·61	–	–	–	–

* On 1st April, 1915, the Urban District of Adwick le Street was constituted out of parts of the Rural District of Doncaster. Allowance has been made in the calculation of rates.

† On 1st April, 1915, the Urban Districts of Cleckheaton, Gomersal, and Liversedge were united to form the Urban District of Spenborough. Allowance has been made in the calculation of rates.

‡ On 1st April, 1915, part of the Urban District of Denby and Cumberworth was transferred to the Urban District of Gunthwaite and Ingbirchworth, and *vice versâ*. The transferred areas contained no population at the Census of 1911.

§ Excluded from the population of the Aggregate of Boroughs and Urban Districts.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Yorkshire, West Riding—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Farnley Tyas	492	–	–	–	–	–	–	–	–	–	–	1	2·03
Farsley	6,129	–	–	2	0·33	6	0·98	3	0·49	–	–	3	0·49
Featherstone	14,220	–	–	78	5·49	6	0·42	12	0·84	–	–	2	0·14
Flockton	1,387	–	–	2	1·44	–	–	1	0·72	–	–	1	0·72
Garforth	3,885	–	–	4	1·03	–	–	8	2·06	2	0·51	1	0·26
Gildersome	3,007	–	–	5	1·66	7	2·33	4	1·33	–	–	2	0·67
Golcar	10,566	–	–	14	1·33	9	0·85	1	0·09	–	–	14	1·33
*Gomersal	3,831†	–	–	8	8·66	–	–	2	2·16	–	–	2	2·16
Goole	19,358	–	–	38	1·96	117	6·04	1	0·05	–	–	10	0·52
Greasbrough	3,195	–	–	12	3·76	2	0·63	1	0·31	1	0·31	4	1·25
Greetland	4,439	–	–	16	3·60	9	2·03	1	0·23	–	–	9	2·03
Guiseley	5,111	–	–	8	1·57	4	0·78	1	0·20	–	–	1	0·20
‡Gunthwaite and Ingbirchworth.	325	–	–	–	–	1	3·08	–	–	–	–	1	3·08
Handsworth	15,216	–	–	44	2·89	32	2·10	1	0·07	–	–	6	0·39
Harrogate	33,933	–	–	69	2·03	27	0·80	2	0·06	–	–	13	0·38
Haworth	6,565	–	–	4	0·61	6	0·91	1	0·15	–	–	3	0·46
Hebden Bridge	6,973	–	–	12	1·72	1	0·14	3	0·43	–	–	3	0·43
Heckmondwike	8,846	–	–	7	0·79	4	0·45	–	–	–	–	10	1·13
Hipperholme	4,799	–	–	1	0·21	12	2·50	–	–	–	–	2	0·42
Holme	378	–	–	9	23·81	–	–	–	–	–	–	–	–
Holmfirth	10,548	–	–	44	4·17	2	0·19	1	0·09	–	–	7	0·66
Honley	4,693	–	–	19	4·05	4	0·85	–	–	–	–	2	0·43
Horbury	7,814	–	–	4	0·51	51	6·53	6	0·77	1	0·13	7	0·90
Horsforth	9,313	–	–	12	1·29	11	1·18	1	0·11	–	–	5	0·54
Hoyland Nether	14,513	–	–	23	1·58	27	1·86	2	0·14	–	–	24	1·65
Hoyland Swaine	592	–	–	2	3·38	–	–	–	–	–	–	–	–
Hunsworth	1,229	–	–	1	0·81	1	0·81	–	–	–	–	–	–
Ilkley	8,107	–	–	25	3·08	2	0·25	4	0·49	–	–	2	0·25
Keighley	42,235	–	–	14	0·33	53	1·25	6	0·14	1	0·02	21	0·50
Kirkburton	3,462	–	–	4	1·16	4	1·16	–	–	–	–	2	0·58
Kirkheaton	2,677	–	–	16	5·98	–	–	–	–	–	–	1	0·37
Knaresborough	4,982	–	–	5	1·00	5	1·00	–	–	–	–	–	–
Knottingley..	6,555	–	–	2	0·31	2	0·31	5	0·76	–	–	2	0·31
Lepton	3,146	–	–	7	2·23	4	1·27	1	0·32	–	–	–	–
Linthwaite	9,856	–	–	11	1·12	6	0·61	–	–	–	–	5	0·51
*Liversedge	14,793†	–	–	11	3·08	2	0·56	1	0·28	–	–	4	1·12
Luddenden Foot	2,870	–	–	10	3·48	1	0·35	1	0·35	–	–	–	–
Marsden	6,050	–	–	17	2·81	6	0·99	1	0·17	–	–	10	1·65
Meltham	4,950	–	–	20	4·04	5	1·01	–	–	–	–	–	–
Methley	4,491	–	–	–	–	2	0·45	3	0·67	–	–	6	1·34
Mexborough	14,465	–	–	48	3·32	20	1·38	5	0·35	–	–	12	0·83
Midgley	1,959	–	–	2	1·02	–	–	4	2·04	–	–	–	–
Mirfield	11,942	–	–	22	1·84	1	0·08	3	0·25	–	–	2	0·17
Monk Bretton	4,763	–	–	25	5·25	8	1·68	1	0·21	–	–	1	0·21
Morley	24,553	–	–	34	1·38	22	0·90	18	0·73	1	0·04	26	1·06
Mytholmroyd	4,160	–	–	5	1·20	5	1·20	1	0·24	–	–	1	0·24
New Mill	4,469	–	–	13	2·91	7	1·57	–	–	–	–	4	0·90
Normanton	15,022	–	–	135	8·99	14	0·93	5	0·33	5	0·33	25	1·66
Oakworth	4,029	–	–	9	2·23	5	1·24	1	0·25	–	–	3	0·74
Ossett	14,345	1	0·07	26	1·81	13	0·91	2	0·14	–	–	13	0·91
Otley	9,600	–	–	9	0·94	32	3·33	1	0·10	–	–	10	1·04
Oxenhope	2,411	–	–	–	–	1	0·41	1	0·41	–	–	–	–
Penistone	3,398	–	–	25	7·36	3	0·88	–	–	–	–	2	0·59
Pontefract	14,909	–	–	106	7·11	12	0·80	15	1·01	1	0·07	13	0·87
Pudsey	14,375	–	–	26	1·81	6	0·42	2	0·14	1	0·07	6	0·42
Queensbury..	6,189	–	–	1	0·16	2	0·32	1	0·16	–	–	5	0·81
Rawdon	3,336	–	–	9	2·70	1	0·30	–	–	1	0·30	3	0·90
Rawmarsh	17,507	–	–	105	6·00	28	1·60	3	0·17	–	–	15	0·86
Ripon	8,411	–	–	9	1·07	37	4·40	1	0·12	–	–	2	0·24
Rishworth	873	–	–	2	2·29	–	–	–	–	–	–	–	–
Rothwell	14,755	–	–	57	3·86	62	4·20	6	0·41	–	–	12	0·81
Royston	6,143	–	–	27	4·40	8	1·30	–	–	1	0·16	2	0·33
Saddleworth	12,493	1	0·08	22	1·76	9	0·72	–	–	1	0·08	5	0·40
Scammonden	370	–	–	1	2·70	–	–	–	–	–	–	–	–
Selby	9,422	–	–	10	1·06	3	0·32	–	–	–	–	3	0·32
Shelf	2,480	–	–	10	4·03	–	–	–	–	2	0·81	1	0·40
Shelley	1,675	–	–	2	1·19	–	–	–	–	–	–	2	1·19
Shepley	1,828	–	–	1	0·55	–	–	–	–	–	–	2	1·09
Shipley	27,995	–	–	32	1·14	40	1·43	–	–	–	–	9	0·32

* On 1st April, 1915, the Urban Districts of Cleckheaton, Gomersal, and Liversedge were united to form the Urban District of Spenborough. Allowance has been made in the calculation of rates.

† Excluded from the population of the Aggregate of Boroughs and Urban Districts.

‡ On 1st April, 1915, part of the Urban District of Denby and Cumberworth was transferred to the Urban District of Gunthwaite and Ingbirchworth, and *vice versâ.* The transferred areas contained no population at the Census of 1911.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Yorkshire, West Riding—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Silsden	5,021	–	–	35	6·97	9	1·79	–	–	–	–	5	1·00
Skelmanthorpe	3,785	–	–	4	1·06	–	–	1	0·26	–	–	4	1·06
Skipton	11,776	–	–	36	3·06	19	1·61	2	0·17	–	–	13	1·10
Slaithwaite	5,525	–	–	27	4·89	3	0·54	–	–	–	–	1	0·18
South Crosland	3,136	–	–	18	5·74	36	11·48	–	–	–	–	–	–
Southowram	2,395	–	–	4	1·67	2	0·84	1	0·42	–	–	2	0·84
Sowerby	3,063	–	–	8	2·61	3	0·98	–	–	–	–	2	0·65
Sowerby Bridge	11,675	–	–	48	4·11	7	0·60	2	0·17	–	–	7	0·60
Soyland	2,824	–	–	25	8·85	–	–	2	0·71	–	–	–	–
*Spenborough	31,608	–	–	33	1·38	13	0·54	4	0·17	1	0·04	11	0·46
Springhead	4,780	–	–	20	4·18	1	0·21	–	–	–	–	1	0·21
Stainland with Old Lindley.	4,437	–	–	12	2·70	7	1·58	–	–	–	–	5	1·13
Stanley	14,365	–	–	14	0·97	19	1·32	8	0·56	1	0·07	12	0·84
Stocksbridge	7,766	–	–	17	2·19	7	0·90	1	0·13	–	–	3	0·39
Swinton	13,092	–	–	26	1·99	39	2·98	25	1·91	–	–	17	1·30
Thurlstone	2,737	–	–	–	–	1	0·37	1	0·37	–	–	3	1·10
Thurnscoe	4,398	–	–	5	1·14	10	2·27	1	0·23	2	0·45	4	0·91
Thurstonland	983	–	–	4	4·07	1	1·02	53	53·92	–	–	–	–
Tickhill	2,008	–	–	2	1·00	1	0·50	–	–	–	–	–	–
Todmorden	24,483	–	–	45	1·84	10	0·41	8	0·33	2	0·08	22	0·90
Wath-upon-Dearne	12,368	–	–	98	7·92	30	2·43	3	0·24	2	0·16	11	0·89
Whitley Upper	840	–	–	3	3·57	–	–	–	–	1	1·19	–	–
Whitwood	5,305	–	–	58	10·93	2	0·38	8	1·51	–	–	1	0·19
Wombwell	18,279	–	–	110	6·02	30	1·64	5	0·27	2	0·11	24	1·31
Worsborough	13,144	–	–	68	5·17	24	1·83	5	0·38	–	–	3	0·23
Yeadon	7,568	–	–	7	0·92	54	7·14	2	0·26	–	–	1	0·13
RURAL DISTRICTS:—													
Barnsley	4,081	–	–	13	3·19	3	0·74	2	0·49	1	0·25	2	0·49
Bishopthorpe	2,116	–	–	13	6·14	–	–	1	0·47	–	–	–	–
Bowland	5,874	–	–	7	1·19	2	0·34	–	–	–	–	1	0·17
†Doncaster	33,426	–	–	106	2·95	50	1·39	35	0·97	2	0·06	19	0·53
Goole	8,266	–	–	47	5·69	23	2·78	2	0·24	–	–	–	–
Great Ouseburn	10,611	–	–	92	8·67	6	0·57	3	0·28	1	0·09	1	0·09
Halifax	6,170	–	–	9	1·46	9	1·46	–	–	–	–	2	0·32
Hemsworth	44,129	–	–	252	5·71	60	1·36	7	0·16	4	0·09	29	0·66
Hunslet	8,003	–	–	15	1·87	2	0·25	3	0·37	–	–	10	1·25
Keighley	6,630	–	–	7	1·06	2	0·30	1	0·15	–	–	1	0·15
Kiveton Park	14,407	–	–	140	9·72	14	0·97	1	0·07	1	0·07	5	0·35
Knaresborough	8,432	–	–	42	4·98	3	0·36	2	0·24	–	–	1	0·12
Pateley Bridge	6,859	–	–	2	0·29	1	0·15	–	–	–	–	5	0·73
Penistone	5,448	–	–	10	1·84	3	0·55	5	0·92	1	0·18	4	0·73
Pontefract	16,224	–	–	62	3·82	17	1·05	7	0·43	1	0·06	1	0·06
Ripon	5,464	–	–	10	1·83	–	–	–	–	–	–	1	0·18
Rotherham	32,140	–	–	175	5·44	36	1·12	3	0·09	3	0·09	38	1·18
Sedbergh	3,595	–	–	–	–	1	0·28	–	–	–	–	1	0·28
Selby	5,823	–	–	10	1·72	1	0·17	1	0·17	–	–	3	0·52
Settle	14,170	–	–	17	1·20	6	0·42	1	0·07	–	–	11	0·78
Skipton	18,844	–	–	27	1·43	4	0·21	1	0·05	–	–	2	0·11
Tadcaster	27,323	–	–	62	2·27	12	0·44	25	0·91	1	0·04	6	0·22
Thorne	9,035	–	–	28	2·10	11	1·22	6	0·66	1	0·11	23	2·55
Todmorden	4,669	–	–	6	1·29	2	0·43	1	0·21	–	–	1	0·21
Wakefield	16,678	–	–	24	1·44	20	1·20	5	0·30	–	–	12	0·72
Wetherby	14,582	–	–	23	1·58	20	1·37	2	0·14	–	–	3	0·21
Wharfedale	7,224	–	–	11	1·52	5	0·69	9	1·25	–	–	16	2·21
Wortley	30,239	–	–	194	6·42	26	0·86	7	0·23	2	0·07	5	0·17
County of Anglesey.													
ADMINISTRATIVE COUNTY	49,647	–	–	166	3·34	46	0·93	6	0·12	1	0·02	6	0·12
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	18,550	–	–	103	5·55	27	1·46	4	0·22	–	–	2	0·11
AGGREGATE OF RURAL DISTRICTS.	31,097	–	–	63	2·03	19	0·61	2	0·06	1	0·03	4	0·13

* On 1st April, 1915, the Urban Districts of Cleckheaton, Gomersal and Liversedge were united to form the Urban District of Spenborough. Allowance has been made in the calculation of rates.

† On 1st April, 1915, parts of the Rural District of Doncaster were constituted the Urban District of Adwick le Street. Allowance has been made in the calculation of rates.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Anglesey—*continued*													
BOROUGHS AND URBAN DISTRICTS:—													
Amlwch	2,694	–	–	10	3·71	–	–	–	–	–	–	1	0·37
Beaumaris	1,863	–	–	4	2·15	–	–	–	–	–	–	–	–
Holyhead	10,751	–	–	77	7·16	24	2·23	2	0·19	–	–	1	0·09
Llangefni	1,637	–	–	–	–	2	1·22	–	–	–	–	–	–
Menai Bridge	1,605	–	–	12	7·48	1	0·62	2	1·25	–	–	–	–
RURAL DISTRICTS:—													
Aethwy	8,507	–	–	11	1·29	7	0·82	–	–	–	–	1	0·12
Dwyran	2,965	–	–	7	2·36	–	–	–	–	–	–	–	–
Twrcelyn	9,049	–	–	8	0·88	3	0·33	2	0·22	–	–	3	0·33
Valley..	10,576	–	–	37	3·50	9	0·85	–	–	1	0·09	–	–
County of Brecknock.													
ADMINISTRATIVE COUNTY	58,389	–	–	207	3·55	121	2·07	15	0·26	7	0·12	32	0·55
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	16,569	–	–	81	4·89	49	2·96	4	0·24	2	0·12	11	0·66
AGGREGATE OF RURAL DISTRICTS.	41,820	–	–	126	3·01	72	1·72	11	0·26	5	0·12	21	0·50
BOROUGHS AND URBAN DISTRICTS:—													
Brecknock	5,264	–	–	9	1·71	4	0·76	–	–	–	–	1	0·19
Brynmawr	7,501	–	–	71	9·47	9	1·20	4	0·53	1	0·13	9	1·20
Builth Wells	1,602	–	–	–	–	35	21·85	–	–	1	0·62	1	0·62
Hay	1,390	–	–	1	0·72	1	0·72	–	–	–	–	–	–
Llanwrtyd	812	–	–	–	–	–	–	–	–	–	–	–	–
RURAL DISTRICTS:—													
Brecknock	9,139	–	–	15	1·64	7	0·77	–	–	1	0·11	1	0·11
Builth	4,141	–	–	3	0·72	14	3·38	2	0·48	1	0·24	1	0·24
Crickhowell..	7,501	–	–	66	8·80	10	1·33	8	1·07	–	–	5	0·67
Hay	3.309	–	–	5	1·51	16	4·84	–	–	–	–	1	0·30
*Llanwrthwl (parish) ..	391	–	–	–	–	–	–	–	–	–	–	–	–
Vaynor and Penderyn ..	5,695	–	–	12	2·11	6	1·05	1	0·18	–	–	1	0·18
†Ystradfellte (parish) ..	647	–	–	–	–	–	–	–	–	–	–	–	–
Ystradgynlais	10,997	–	–	25	2·27	19	1·73	–	–	3	0·27	12	1·09
County of Cardigan.													
ADMINISTRATIVE COUNTY	57,323	–	–	207	3·61	50	0·87	6	0·10	3	0·05	23	0·40
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	15,576	–	–	54	3·47	16	1·03	4	0·26	–	–	9	0·58
AGGREGATE OF RURAL DISTRICTS.	41,747	–	–	153	3·66	34	0·81	2	0·05	3	0·07	14	0·34
BOROUGHS AND URBAN DISTRICTS:—													
Aberayron	1,360	–	–	1	0·74	–	–	1	0·74	–	–	–	–
Aberystwyth	7,841	–	–	31	3·95	6	0·77	1	0·13	–	–	8	1·02
Cardigan	3,429	–	–	4	1·17	10	2·92	1	0·29	–	–	–	–
Lampeter	1,682	–	–	15	8·92	–	–	1	0·59	–	–	1	0·59
New Quay	1,264	–	–	3	2·37	–	–	–	–	–	–	–	–
RURAL DISTRICTS:—													
Aberayron	7,663	–	–	30	3·91	3	0·39	1	0·13	–	–	4	0·52
Aberystwyth	12,217	–	–	47	3·85	4	0·33	1	0·08	2	0·16	6	0·49
Cardigan	3,063	–	–	24	7·84	–	–	–	–	–	–	–	–
Lampeter	3,426	–	–	12	3·50	4	1·17	–	–	–	–	–	–
Llandyssul	7,774	–	–	31	3·99	15	1·93	–	–	–	–	–	–
‡Scybor-y-coed (parish) ..	397	–	–	–	–	–	–	–	–	–	–	1	2·52
Tregaron	7,207	–	–	9	1·25	8	1·11	–	–	1	0·14	3	0·42

* This parish is administered by the Rural District Council of Rhayader (Radnor).
† This parish is administered by the Rural District Council of Neath (Glamorgan).
‡ This parish is administered by the Rural District Council of Machynlleth (Montgomery).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Carmarthen.													
ADMINISTRATIVE COUNTY	163,622	–	–	1,031	6·30	148	0·90	14	0·09	21	0·13	87	0·53
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	66,053	–	–	572	8·66	47	0·71	5	0·08	10	0·15	32	0·48
AGGREGATE OF RURAL DISTRICTS.	97,569	–	–	459	4·70	101	1·04	9	0·09	11	0·11	55	0·56
BOROUGHS AND URBAN DISTRICTS:—													
Ammanford..	6,504	–	–	90	13·84	8	1·23	–	–	–	–	7	1·08
Burry Port	5,330	–	–	41	7·69	5	0·94	1	0·19	–	–	4	0·75
Carmarthen..	8,634	–	–	16	1·85	6	0·69	–	–	–	–	1	0·12
Cwmamman	4,951	–	–	7	1·41	–	–	–	–	1	0·20	1	0·20
Kidwelly	2,903	–	–	–	–	–	–	–	–	–	–	–	–
Llandilo	1,714	–	–	19	11·09	4	2·33	–	–	–	–	2	1·17
Llandovery	1,708	–	–	–	–	–	–	–	–	–	–	2	1·17
Llanelly	33,487	–	–	395	11·80	24	0·72	2	0·06	9	0·27	15	0·45
Newcastle Emlyn.. ..	822	–	–	4	4·87	–	–	2	2·43	–	–	–	–
RURAL DISTRICTS:—													
Carmarthen..	24,553	–	–	82	3·34	12	0·49	–	–	1	0·04	12	0·49
Llandilofawr	20,739	–	–	141	6·80	37	1·78	–	–	5	0·24	19	0·92
Llandovery	7,040	–	–	4	0·57	3	0·43	–	–	–	–	1	0·14
Llanelly	30,256	–	–	219	7·24	31	1·02	9	0·30	5	0·17	18	0·59
Llanybyther	3,603	–	–	1	0·28	3	0·83	–	–	–	–	2	0·56
Newcastle in Emlyn ..	6,395	–	–	9	1·41	10	1·56	–	–	–	–	2	0·31
Whitland	4,983	–	–	3	0·60	5	1·00	–	–	–	–	1	0·20
County of Carnarvon.													
ADMINISTRATIVE COUNTY	116,633	–	–	212	1·82	98	0·84	11	0·09	4	0·03	58	0·50
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	54,804	–	–	103	1·88	40	0·73	7	0·13	3	0·05	22	0·40
AGGREGATE OF RURAL DISTRICTS.	61,829	–	–	109	1·76	58	0·94	4	0·06	1	0·02	36	0·58
BOROUGHS AND URBAN DISTRICTS:—													
Bangor	10,017	–	–	37	3·69	9	0·90	2	0·20	1	0·10	4	0·40
Bethesda	4,048	–	–	2	0·49	–	–	–	–	–	–	–	–
Bettws y Coed	791	–	–	–	–	1	1·26	1	1·26	1	1·26	–	–
Carnarvon	8,331	–	–	3	0·36	2	0·24	–	–	–	–	10	1·20
Conway	5,021	–	–	8	1·59	6	1·19	3	0·60	–	–	1	0·20
Criccieth	1,532	–	–	10	6·53	2	1·31	–	–	–	–	2	1·31
Llandudno	10,525	–	–	13	1·24	19	1·81	1	0·10	–	–	–	–
Llanfairfechan	2,947	–	–	24	8·14	–	–	–	–	–	–	3	1·02
Penmaenmawr	3,718	–	–	5	1·34	–	–	–	–	1	0·27	–	–
Pwllheli	3,676	–	–	1	0·27	1	0·27	–	–	–	–	–	–
Ynyscynhaiarn (Portmadoc).*	4,198	–	–	–	–	–	–	–	–	–	–	2	0·48
RURAL DISTRICTS:—													
Conway	7,465	–	–	18	2·41	18	2·41	2	0·27	1	0·13	3	0·40
Geirionydd	3,851	–	–	–	–	3	0·78	–	–	–	–	2	0·52
Glaslyn	3,111	–	–	–	–	–	–	–	–	–	–	–	–
Gwyrfai	24,595	–	–	41	1·67	13	0·53	1	0·04	–	–	26	1·06
Lleyn	16,916	–	–	39	2·31	23	1·36	–	–	–	–	2	0·12
Ogwen	5,891	–	–	11	1·87	1	0·17	1	0·17	–	–	3	0·51
County of Denbigh.													
ADMINISTRATIVE COUNTY.	140,756	–	–	308	2·19	159	1·13	9	0·06	5	0·04	49	0·35
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	45,933	–	–	112	2·44	23	0·50	5	0·11	–	–	16	0·35
AGGREGATE OF RURAL DISTRICTS.	94,823	–	–	196	2·07	136	1·43	4	0·04	5	0·05	33	0·35
BOROUGHS AND URBAN DISTRICTS:—													
Abergele and Pensarn ..	2,171	–	–	10	4·61	1	0·46	–	–	–	–	–	–
Colwyn Bay and Colwyn	12,694	–	–	27	2·13	6	0·47	1	0·08	–	–	5	0·39
Denbigh	5,555	–	–	26	4·68	5	0·90	4	0·72	–	–	6	1·08
Llangollen	3,015	–	–	–	–	–	–	–	–	–	–	–	–
Llanrwst	2,256	–	–	–	–	3	1·33	–	–	–	–	1	0·44
Ruthin	2,476	–	–	9	3·63	–	–	–	–	–	–	–	–
Wrexham	17,766	–	–	40	2·25	8	0·45	–	–	–	–	4	0·23

* The Urban District of Ynyscynhaiarn was re-named Portmadoc on 3rd December, 1915.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Denbigh—*continued.*													
RURAL DISTRICTS:—													
Chirk	4,412	–	–	1	0·23	6	1·36	–	–	–	–	4	0·91
*Glan Conway and Llanelian (parishes).	1,778	–	–	–	–	16	9·00	–	–	–	–	–	–
Llangollen	3,627	–	–	1	0·28	–	–	–	–	–	–	–	–
Llanrwst	4,239	–	–	1	0·24	17	4·01	–	–	–	–	1	0·24
Llansilin	3,010	–	–	3	1·00	3	1·00	–	–	–	–	–	–
Ruthin	8,553	–	–	17	1·99	9	1·05	–	–	–	–	5	0·58
St. Asaph (Denbigh) ..	7,435	–	–	6	0·81	7	0·94	1	0·13	–	–	1	0·13
Uwchaled	2,344	–	–	5	2·13	–	–	–	–	1	0·43	–	–
Wrexham	59,425	–	–	162	2·73	78	1·31	3	0·05	4	0·07	22	0·37
County of Flint.													
ADMINISTRATIVE COUNTY	92,944	–	–	367	3·95	438	4·71	15	0·16	7	0·08	49	0·53
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	35,653	–	–	155	4·35	258	7·24	7	0·20	4	0·11	21	0·59
AGGREGATE OF RURAL DISTRICTS.	57,291	–	–	212	3·70	180	3·14	8	0·14	3	0·05	28	0·49
BOROUGHS AND URBAN DISTRICTS:—													
Buckley	6,473	–	–	1	0·15	23	3·55	1	0·15	4	0·62	3	0·46
Connah's Quay	4,716	–	–	125	26·51	21	4·45	2	0·42	–	–	1	0·21
Flint	5,448	–	–	9	1·65	16	2·94	3	0·55	–	–	8	1·47
Holywell	2,515	–	–	1	0·40	8	3·18	–	–	–	–	1	0·40
Mold	4,464	–	–	4	0·90	5	1·12	1	0·22	–	–	3	0·67
Prestatyn	2,431	–	–	6	2·47	1	0·41	–	–	–	–	–	–
Rhyl	9,606	–	–	9	0·94	184	19·15	–	–	–	–	5	0·52
RURAL DISTRICTS:—													
Hawarden	21,734	–	–	83	3·82	56	2·58	2	0·09	1	0·05	6	0·28
Holywell	24,039	–	–	106	4·41	92	3·83	2	0·08	2	0·08	16	0·67
Overton	5,007	–	–	17	3·40	16	3·20	1	0·20	–	–	4	0·80
St. Asaph	6,511	–	–	6	0·92	16	2·46	3	0·46	–	–	2	0·31
County of Glamorgan.													
ADMINISTRATIVE COUNTY	766,720	–	–	3,825	4·99	1,170	1·53	148	0·19	59	0·08	430	0·56
COUNTY BOROUGHS:—													
Cardiff	184,900	–	–	752	4·07	472	2·55	20	0·11	12	0·06	104	0·56
Merthyr Tydfil	76,493	–	–	186	2·43	51	0·67	6	0·08	7	0·09	60	0·78
Swansea	110,843	–	–	297	2·68	129	1·16	10	0·09	3	0·03	61	0·55
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	548,788	–	–	2,547	4·64	812	1·48	114	0·21	50	0·09	303	0·55
AGGREGATE OF RURAL DISTRICTS.	217,932	–	–	1,278	5·86	358	1·64	34	0·16	9	0·04	127	0·58
BOROUGHS AND URBAN DISTRICTS:—													
Aberavon	12,319	–	–	32	2·60	4	0·32	1	0·08	–	–	6	0·49
Aberdare	51,279	–	–	322	6·28	57	1·11	9	0·18	3	0·06	39	0·76
Barry	35,222	–	–	202	5·74	154	4·37	18	0·51	5	0·14	30	0·85
Bridgend	7,778	–	–	79	10·16	10	1·29	4	0·51	1	0·13	5	0·64
Briton Ferry	8,539	–	–	62	7·26	–	–	1	0·12	3	0·35	–	–
Caerphilly	33,112	–	–	125	3·78	81	2·45	4	0·12	3	0·09	5	0·15
Cowbridge	1,033	–	–	7	6·78	–	–	–	–	–	–	–	–
Gelligaer	37,503	–	–	157	4·19	54	1·44	10	0·27	2	0·05	13	0·35
Glyncorwg	9,563	–	–	26	2·72	27	2·82	3	0·31	–	–	4	0·42
Maesteg	26,138	–	–	390	14·92	34	1·30	1	0·04	–	–	14	0·54
Margam	15,693	–	–	56	3·57	14	0·89	2	0·13	1	0·06	10	0·64
Mountain Ash	41,003	–	–	154	3·76	48	1·17	6	0·15	4	0·10	37	0·90
Neath	16,532	–	–	79	4·78	27	1·63	1	0·06	2	0·12	17	1·03
Ogmore and Garw ..	27,490	–	–	172	6·26	42	1·53	15	0·55	2	0·07	13	0·47
Oystermouth	6,737	–	–	15	2·23	9	1·34	1	0·15	1	0·15	5	0·74
Penarth	15,620	–	–	28	1·79	7	0·45	1	0·06	–	–	2	0·13
Pontypridd	42,583	–	–	60	1·41	35	0·82	5	0·12	1	0·02	15	0·35
Porthcawl	4,384	–	–	9	2·05	4	0·91	1	0·23	–	–	–	–
Rhondda	156,260	–	–	572	3·66	205	1·31	31	0·20	22	0·14	88	0·56
RURAL DISTRICTS:—													
Cowbridge	8,212	–	–	54	6·58	52	6·33	–	–	–	–	4	0·49
Gower	8,728	–	–	40	4·58	1	0·11	2	0·23	–	–	3	0·34

* These parishes are administered by the Rural District Council of Conway (Carnarvon).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

—	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Glamorgan —*continued.*													
RURAL DISTRICTS :—													
Llandaff and Dinas Powis	37,022	–	–	115	3·11	103	2·78	3	0·08	1	0·03	12	0·32
Llantrisant and Llantwit Fardre.	20,982	–	–	131	6·24	57	2·72	2	0·10	1	0·05	8	0·38
Neath	42,929	–	–	452	10·53	55	1·28	13	0·30	5	0·12	17	0·40
Penybont	20,640	–	–	107	5·18	37	1·79	2	0·10	1	0·05	37	1·79
Pontardawe..	32,506	–	–	183	5·63	19	0·58	9	0·28	–	–	20	0·62
Swansea	46,913	–	–	196	4·18	34	0·72	3	0·06	1	0·02	26	0·55
County of Merioneth.													
ADMINISTRATIVE COUNTY	42,378	–	–	123	2·90	43	1·01	2	0·05	–	–	37	0·87
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	18,374	–	–	66	3·59	24	1·31	–	–	–	–	34	1·85
AGGREGATE OF RURAL DISTRICTS.	24,004	–	–	57	2·37	19	0·79	2	0·08	–	–	3	0·12
BOROUGHS AND URBAN DISTRICTS :—													
Bala	1,342	–	–	–	–	–	–	–	–	–	–	–	–
Barmouth	2,338	–	–	1	0·43	–	–	–	–	–	–	–	–
Dolgelly	1,927	–	–	2	1·04	–	–	–	–	–	–	–	–
Festiniog	8,087	–	–	37	4·58	24	2·97	–	–	–	–	32	3·96
Mallwyd	735	–	–	1	1·36	–	–	–	–	–	–	–	–
Towyn	3,945	–	–	25	6·34	–	–	–	–	–	–	2	0·51
RURAL DISTRICTS :—													
Deudraeth	7,209	–	–	21	3·33	9	1·25	–	–	–	–	–	–
Dolgelly	7,810	–	–	16	2·05	–	–	1	0·13	–	–	1	0·13
Edeirnion	4,673	–	–	10	2·14	10	2·14	–	–	–	–	–	–
Penllyn	3,903	–	–	7	1·79	–	–	1	0·26	–	–	2	0·51
*Pennal (parish)	409	–	–	–	–	–	–	–	–	–	–	–	–
County of Monmouth.													
ADMINISTRATIVE COUNTY	323,882	–	–	2360	7·29	329	1·02	63	0·19	23	0·07	194	0·60
COUNTY BOROUGH :—													
Newport	80,579	–	–	202	2·51	92	1·14	10	0·12	9	0·11	47	0·58
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	280,935	–	–	2228	7·93	313	1·11	60	0·21	21	0·07	191	0·68
AGGREGATE OF RURAL DISTRICTS.	42,947	–	–	132	3·07	16	0·37	3	0·07	2	0·05	3	0·07
BOROUGHS AND URBAN DISTRICTS :—													
Abercarn	18,371	–	–	39	2·12	3	0·16	3	0·16	–	–	4	0·22
Abergavenny	8,044	–	–	36	4·48	10	1·24	1	0·12	–	–	6	0·75
Abersychan	25,574	–	–	343	13·41	16	0·63	6	0·23	2	0·08	20	0·78
Abertillery	37,091	–	–	232	6·25	41	1·11	8	0·22	1	0·03	13	0·35
Bedwas and Machen ..	7,358	–	–	24	3·26	29	3·94	3	0·41	–	–	4	0·54
Bedwellty	26,419	–	–	123	4·66	57	2·16	4	0·15	1	0·04	14	0·53
Blaenavon	12,188	–	–	74	6·07	–	–	1	0·08	–	–	14	1·15
Caerleon	1,677	–	–	–	–	–	–	–	–	1	0·60	2	1·19
Chepstow	2,638	–	–	4	1·52	3	1 14	–	–	–	–	–	–
Ebbw Vale	31,738	–	–	750	23·63	7	0·22	9	0·28	5	0·16	39	1·23
Llanfrechfa Upper ..	4,469	–	–	5	1·12	–	–	–	–	–	–	7	1·57
Llantarnam	6,673	–	–	25	3·75	2	0·30	–	–	–	–	1	0·15
Monmouth	4,646	–	–	9	1·94	5	1·08	1	0·22	–	–	–	–
Mynyddislwyn	12,212	–	–	35	2·87	8	0·66	–	–	–	–	3	0·25
Nantyglo and Blaina ..	15,175	–	–	35	2·31	8	0·53	–	–	–	–	10	0·66
Panteg	10,152	–	–	78	7·68	12	1·18	–	–	–	–	7	0·69
Pontypool	5,906	–	–	75	12·70	6	1·02	1	0·17	–	–	1	0·17
Rhymney	10,761	–	–	62	5·76	16	1·49	2	0·19	3	0·28	20	1·86
Risca	15,402	–	–	17	1·10	5	0·32	3	0·19	–	–	–	–
Tredegar	23,162	–	–	261	11·27	85	3·67	17	0·73	8	0·35	26	1·12
Usk	1,279	–	–	1	0·78	–	–	1	0·78	–	–	–	–
RURAL DISTRICTS :—													
Abergavenny	7,910	–	–	38	4·80	3	0·38	1	0·13	–	–	–	–
Chepstow	8,171	–	–	30	3·67	3	0·37	–	–	–	–	1	0·12
Magor	4,960	–	–	6	1·21	–	–	1	0·20	2	0·40	1	0·20
Monmouth	6,436	–	–	4	0·62	1	0·16	–	–	–	–	1	0·16
Pontypool	4,944	–	–	11	2·22	1	0·20	–	–	–	–	–	–
St. Mellons	10,526	–	–	43	4·09	8	0·76	1	0·10	–	–	–	–

* This parish is administered by the Rural District Council of Machynlleth (Montgomery).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1915—*continued.*

——	Estimated Civil Population in the middle of 1915.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Montgomery													
ADMINISTRATIVE COUNTY.	50,473	–	–	65	1·29	20	0·40	2	0·04	–	–	19	0·38
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	17,767	–	–	18	1·01	3	0·17	2	0·11	–	–	8	0·45
AGGREGATE OF RURAL DISTRICTS.	32,706	–	–	47	1·44	17	0·52	–	–	–	–	11	0·34
BOROUGHS AND URBAN DISTRICTS :—													
Llanfyllin	1,434	–	–	–	–	–	–	–	–	–	–	1	0·70
Llanidloes	2,466	–	–	2	0·81	–	–	1	0·41	–	–	–	–
Machynlleth	1,826	–	–	3	1·64	1	0·55	–	–	–	–	–	–
Montgomery	908	–	–	4	4·41	–	–	1	1·10	–	–	–	–
Newtown and Llanllwchaiarn.	5,636	–	–	4	0·71	2	0·35	–	–	–	–	–	–
Welshpool	5,497	–	–	5	0·91	–	–	–	–	–	–	7	1·27
RURAL DISTRICTS :—													
Forden	5,397	–	–	4	0·74	–	–	–	–	–	–	3	0·56
Llanfyllin	12,305	–	–	6	0·49	7	0·57	–	–	–	–	4	0·33
Machynlleth	3,927	–	–	14	3·57	–	–	–	–	–	–	1	0·25
Newtown and Llanidloes	11,077	–	–	23	2·08	10	0·90	–	–	–	–	3	0·27
County of Pembroke.													
ADMINISTRATIVE COUNTY	87,825	–	–	290	3·30	76	0·87	22	0·25	7	0·08	34	0·39
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	38,272	–	–	179	4·68	55	1·44	8	0·21	5	0·13	24	0·63
AGGREGATE OF RURAL DISTRICTS.	49,553	–	–	111	2·24	21	0·42	14	0·28	2	0·04	10	0·20
BOROUGHS AND URBAN DISTRICTS :—													
Fishguard	2,923	–	–	–	–	1	0·34	–	–	–	–	–	–
Haverfordwest	5,540	–	–	5	0·90	4	0·72	–	–	1	0·18	4	0·72
Milford Haven	6,770	–	–	20	2·95	29	4·28	3	0·44	3	0·44	2	0·30
Narberth	1,111	–	–	1	0·90	1	0·90	1	0·90	–	–	–	–
Neyland	2,565	–	–	5	1·95	1	0·39	4	1·56	1	0·39	2	0·78
Pembroke	15,380	–	–	146	9·49	14	0·91	–	–	–	–	16	1·04
Tenby	3,983	–	–	2	0·50	5	1·26	–	–	–	–	–	–
RURAL DISTRICTS :—													
Haverfordwest	20,510	–	–	35	1·71	12	0·59	3	0·15	1	0·05	7	0·34
Llanfyrnach	2,409	–	–	8	3·32	–	–	–	–	–	–	–	–
Narberth	10,596	–	–	20	1·89	5	0·47	1	0·09	–	–	–	–
Pembroke	8,059	–	–	22	2·73	–	–	3	0·37	1	0·12	–	–
St. Dogmells	7,979	–	–	26	3·26	4	0·50	7	0·88	–	–	3	0·38
County of Radnor.													
ADMINISTRATIVE COUNTY	21,771	–	–	37	1·70	20	0·92	1	0·05	3	0·14	1	0·05
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	5,715	–	–	19	3·32	–	–	1	0·17	–	–	–	–
AGGREGATE OF RURAL DISTRICTS.	16,056	–	–	18	1·12	20	1·25	–	–	3	0·19	1	0·06
BOROUGHS AND URBAN DISTRICTS :—													
Knighton	1,703	–	–	3	1·76	–	–	–	–	–	–	–	–
Llandrindod Wells ..	2,933	–	–	11	3·75	–	–	1	0·34	–	–	–	–
Presteign	1,079	–	–	5	4·63	–	–	–	–	–	–	–	–
RURAL DISTRICTS :—													
Colwyn	1,938	–	–	7	3·61	4	2·06	–	–	2	1·03	–	–
Knighton	4,397	–	–	–	–	2	0·45	–	–	–	–	1	0·23
New Radnor	2,633	–	–	1	0·38	–	–	–	–	–	–	–	–
Painscastle	2,145	–	–	–	–	14	6·53	–	–	1	0·47	–	–
Rhayader	4,913	–	–	10	2·02	–	–	–	–	–	–	–	–

2

REPORTS

TO THE

LOCAL GOVERNMENT BOARD

ON

PUBLIC HEALTH AND MEDICAL SUBJECTS.

(*NEW SERIES*, *No.* 110.)

REPORTS ON CEREBRO-SPINAL FEVER.

1. Memorandum by the Medical Officer of the Board.
2. Dr. Eastwood's Report on Bacteriological Aspects of the Carrier Problem.
3. Dr. F. Griffith's Report on Identification of the Meningococcus in the Naso-Pharynx with special reference to Serological Reactions.
4. Dr. W. M. Scott's Report on Meningococci occurring in the Spinal Fluid and in the Naso-Pharynx.
5. Dr. R. J. Reece's Report on the epidemic prevalence of Cerebro-Spinal Fever in England and Wales during the first six months of 1915.
6. Dr. Bruce Low's Report on the prevalence and distribution of Cerebro-Spinal Fever during recent years.

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1916.

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CONTENTS.

I.—Preliminary Memorandum by the Medical Officer of the Board.

During the years 1913 and 1914 cerebro-spinal fever prevailed in this country to a somewhat greater extent than had previously been experienced; and in the first half of the year 1915 this increase assumed large proportions. The disease became compulsorily notifiable from September 1st, 1912, and in the remainder of that year 104 cases were notified. In 1913 the number notified was 305, and in 1914 the number was 315. In 1915 the number of cases in the civil population had increased to 2,565. (The numbers are subject to considerable modification after later inquiry into each individual case.) This increase coincided with the military mobilisation of a large part of the adult male population. The number of notifications week by week in the civil and the military population respectively in England and Wales since the second month of the War up to the end of the year 1915 is shown in the curves on page 6.

Arising out of the increased prevalence of cerebro-spinal fever in this country, in February of last year a revised medical memorandum on this disease was prepared and has been circulated to local authorities by the Board.

It was recognised at that time that great diagnostic value attached to the discovery of meningococci in the cerebro-spinal fluid of patients suffering from meningitis, but that it was doubtful what measure of importance should attach to the finding of meningococcus-like organisms in the naso-pharynx of contacts with cases of cerebro-spinal fever.

The Board, in the circular letter covering the above-mentioned memorandum, undertook to examine in their Pathological Laboratory specimens of cerebro-spinal fluid sent to them by medical officers of health; and in the memorandum it was advised that contacts with patients should be regarded as possibly infectious and subject to partial restrictions in their intercourse with others for three weeks from the date of last association with a patient, unless swabs from the naso-pharynx, examined under specified conditions, had twice failed to show the presence of the meningococcus.

At the same time, in view of the inherent difficulties in controlling the spread of cerebro-spinal fever, and of the existing doubt as to the extent of utility of examination of specimens from the naso-pharynx of contacts, the Board authorised a special investigation into the extent to which meningococci are present in the naso-pharynx of persons who, so far as can be ascertained, have not on any occasion been associated with cerebro-spinal fever patients.

This investigation has been carried out in the Board's Pathological Laboratory by Drs. Eastwood and F. Griffith, with whom Dr. W. M. Scott has been associated. The special reports of these investigators follow this preliminary memorandum, together with Dr. Reece's report on the epidemic of cerebro-spinal fever during the first six months of 1915, and Dr. Bruce Low's review of the history of cerebro-spinal fever in this and in other countries.

(4242.) Wt. 45129—495. 1,000. 4/16. J. T. & S. G. 14.

From Dr. Eastwood's historical survey (pp. 9 to 36) of bacteriological literature on the meningococcus published during the years 1906–14, it is evident that swabs from the naso-pharynx of persons not associated with cerebro-spinal fever have not infrequently yielded organisms which were indistinguishable from meningococci by microscopic, cultural, and fermentation tests. Hence the attempts made, during the period under review, to obtain greater certitude of differential diagnosis by means of serological tests. This work has been complicated by the fact that different strains of undoubted meningococci differ amongst themselves in their serological reactions, and that therefore a negative result with a naso-pharyngeal strain tested upon a particular serum did not justify the exclusion of that strain from the class of meningococci.

Dr. Eastwood, working in conjunction with Dr. Griffith, examined samples taken from the naso-pharynx of 480 out-patients at St. Bartholomew's Hospital. These specimens were obtained by an aural surgeon; they were examined without the hurry which is liable to be associated with examinations made under the local circumstances of an outbreak of disease, and the collection and subsequent processes were carried out under conditions which greatly reduced the likelihood of overlooking any meningococci present. The specimens were obtained from a hospital population (for particulars see pp. 38–39), and are not, therefore, representative of a normal healthy population.

When allowance is made for these considerations, it is noteworthy that organisms indistinguishable from meningococci were found in the naso-pharynx of 13·4 per cent. of the 269 males examined, in 6·2 per cent. of the 211 females examined, and in 10·2 per cent. of the total 480 persons examined. The recognised microscopic, cultural, and fermentation tests were employed in each instance. Pharyngitis was carefully noted when present at the time the sample was taken. It was not found in a conspicuously large number of the positive cases.

Dr. Griffith (pp. 41 to 56) proceeded to apply serological tests to 28 of the above naso-pharyngeal strains, using seven monovalent sera prepared from cerebro-spinal strains obtained during the present outbreak. Fifteen of the naso-pharyngeal strains agglutinated, with one or other of the above sera, up to 1 : 200, or in higher dilutions, and five of these were shown also to absorb the specific agglutinin; six agglutinated up to 1 : 100, but not in higher dilutions; seven failed to agglutinate, or did not agglutinate in higher dilution than 1 : 50.

Dr. Scott, in addition to his investigation of cerebro-spinal fever cases (pp. 56 to 67), also examined the condition of the "non-contact" throat. Working on parallel lines with Drs. Eastwood and Griffith, he made bacteriological examination of naso-pharyngeal swabs, taken by himself, from 138 individuals attending the out-patient department of Lambeth Infirmary; he also examined swabs from 56 children attending a rural school in Kent.

Thirty of the Lambeth patients and one of the school children were found positive by cultural and fermentation tests.

Proceeding to serological tests with strains from 29 of these 31 individuals, Dr. Scott found that seven showed complete agglutination at 1:200, or in higher dilution, and 12 at 1:100 with one or more of the four monovalent sera used, each of which had been prepared with a strain of undoubted meningococci—*i.e.*, a total of 19 showed well-marked agglutination. The remaining 10, including that from the school child, showed no more than slight agglutination, or traces of agglutination, with the sera employed.

The special importance of the results obtained in the Board's investigation consists in their relating to persons who, so far as could be ascertained, had never been in association with cases of cerebro-spinal fever.

It is evidently desirable that this work should be continued and extended, and further work on the same lines is now in progress.

Dr. Reece's report on pp. 73 to 114 details the experience of certain parts of England and Wales during the first six months of 1915 as regards cerebro-spinal fever. As Dr. Reece has had special charge of military preventive measures against cerebro-spinal fever, his account may be regarded as in part embodying military as well as civil experience. This report is to be regarded as only preliminary in character. Further inquiry into available data will, it is hoped, permit of a more complete account at a later date.

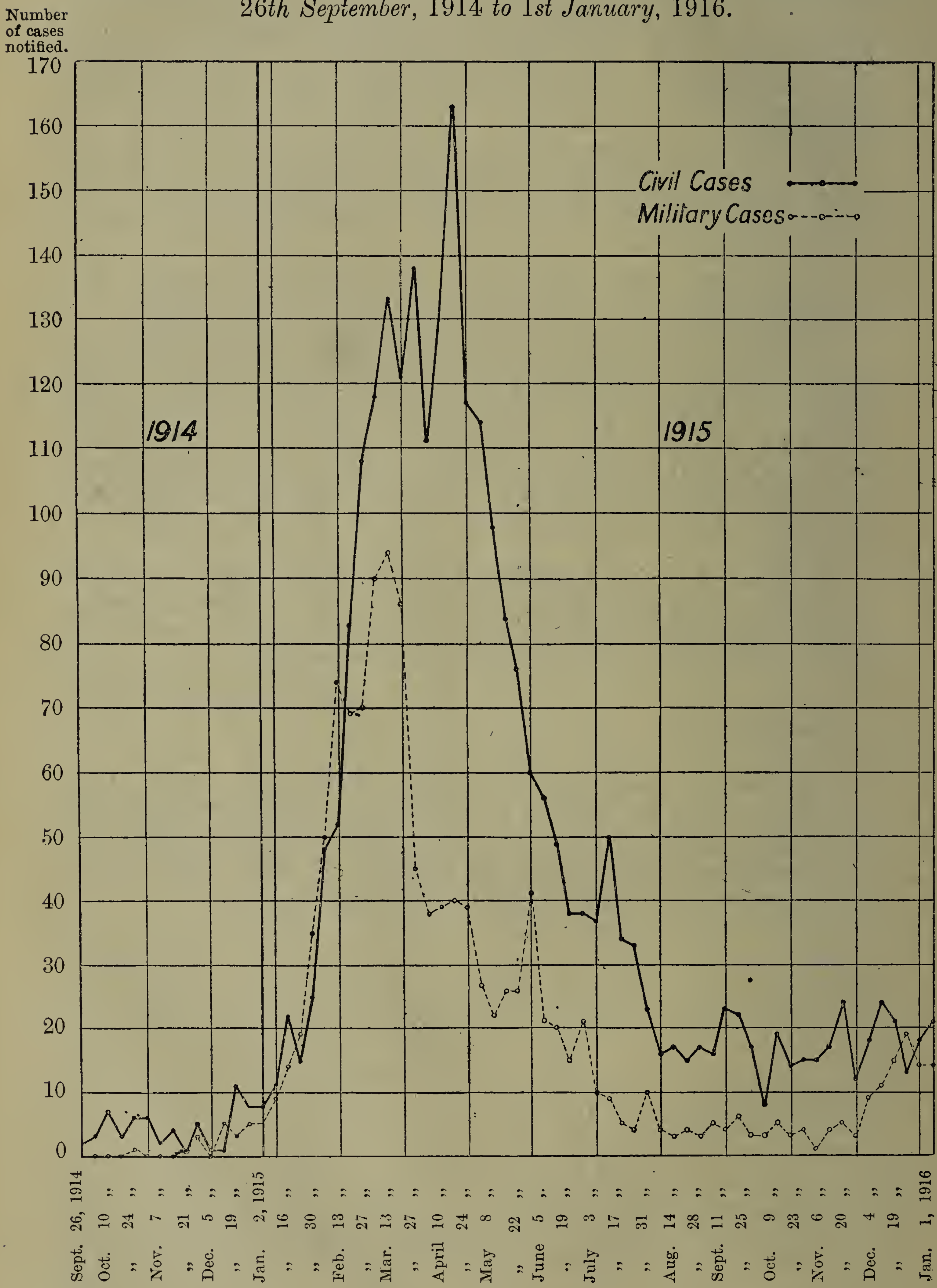
Dr. Bruce Low has contributed, on pp. 115 to 183, a review of the history of cerebro-spinal fever in this and in other countries, which throws much light on the disease, and gives some guidance as to the likely course of the disease in future years.

ARTHUR NEWSHOLME.

January, 1916.

P.S.—While this Report is passing through the press, there has been issued the Report of the Special Advisory Committee (Medical Research Committee) upon Bacteriological Studies of Cerebro-Spinal Fever during the epidemic of 1915, which should be consulted in conjunction with this report.

Cerebro-spinal fever in England and Wales—Cases notified week by week, 26th September, 1914 to 1st January, 1916.



II.—Bacteriological Aspects of the Meningococcus Carrier Problem; by A. Eastwood, M.D.

Introduction.

During the year 1915 Drs. F. Griffith, W. M. Scott and I have been investigating the meningococcus in the Board's Pathological Laboratory with the object of providing information which may be of service to the Board, particularly with reference to the carrier problem.

Before entering into technical details I wish to state in general terms the problems which present themselves and the difficulties which are to be overcome.

There is an obvious difference between diagnosing the meningococcus in cerebro-spinal fluid withdrawn from a patient with symptoms of meningitis and identifying this organism in a culture from the naso-pharynx of a person not clinically affected with the disease. Assuming the two organisms to be alike in cultural characters, with the former the confirmatory evidence of specific pathogenicity is supplied by the condition of the patient; with the latter organism, this confirmatory proof is lacking. In the case of such organisms as the bacilli of plague, tuberculosis, or anthrax, the proof could readily be provided by animal experiment; but for the meningococcus, as for the typhoid bacillus, there is no laboratory animal available for routine demonstration of specific pathogenicity. It is therefore necessary to be content with indirect evidence that an organism isolated from the naso-pharynx is capable of producing cerebro-spinal fever.

The question then arises whether morphological and cultural characters alone, if worked out with sufficient care, can be accepted as giving complete identification. These characters, including fermentation tests, are certainly of very great aid to diagnosis, and there is practically complete agreement about what cultural characteristics are to be regarded as typical of the true meningococcus. As, however, some little differences of opinion have been expressed regarding the fermentation of sugars, this question will be treated in this report as a problem calling for consideration.

But, assuming this question of fermentation reactions to be settled, it must still be admitted that more confidence would be felt in the fermentation tests if they could be confirmed by other tests of a more specific nature. This naturally suggests an appeal to serological reactions. If, for example, strains from the naso-pharynx agreed with undoubted meningococci, not only in cultural and fermentation tests, but also in agglutination with a specific

serum, their identity might be admitted; and, if the correspondence between fermentation and agglutination tests was a regular occurrence, the question might be raised whether resort to the latter might, except under exceptional circumstances, be considered unnecessary for routine diagnosis. But here a preliminary and very serious difficulty arises owing to the fact that different strains of undoubted meningococci differ among themselves in their serological reactions; and no serum is available which can be guaranteed to agglutinate every strain of meningococcus without fail. Obviously, here is a problem where research is needed.

It will probably be a long time before a complete scientific explanation is accepted for the serological reactions of all strains of meningococci isolated from cerebro-spinal fever; but, in the meantime, this consideration is no bar to comparison, with such sera as are available, between the agglutination of undoubted meningococci and that of strains isolated from the naso-pharynx. It is clearly a matter of immediate interest to see if identity can be established between the former and the latter.

Difficulties in serological work with the meningococcus, though still very considerable, are not now, and never have been, of such a nature as to render such investigations useless. Ten years ago identity in serum reactions had been established between certain strains from cerebro-spinal fluid and certain strains from the naso-pharynx. These latter strains had been mainly derived from contacts, but they had also, though in much smaller numbers, been obtained from non-contacts.

This last fact raises a question which demands urgent consideration at the present time. What practical advantage is to be gained by culturing swabs from the naso-pharynx as a routine aid to prophylactic measures? It cannot be taken for granted, without adequate bacteriological evidence, that the meningococcus is so frequently present in the normal, or merely catarrhal, throat as the pneumococcus, or, possibly, the influenza bacillus. But still it may come under the same stigma of the bacteriological class of "common lodger," which, though more frequently innocuous, or relatively so, is capable, under favourable conditions of reduced resistance, of producing its specific disease. If that is the case, the meningococcus carrier must obviously be placed in a different class from, for example, the typhoid carrier. So the practical question is, Is it true that in this country and at the present time, when precautions have to be taken against the spread of cerebro-spinal fever, the meningococcus is to be found widely distributed in the throats of persons not known to have been in contact with the disease?

This is the main problem which has been engaging the attention of the Board's Laboratory. The investigation has involved research in the directions I have already indicated, viz.:—(1) a comparative study of the fermentation and serological reactions of various strains of meningococci derived from the cerebro-spinal fluid of patients affected with meningitis; (2) a similar study of various meningococcus-like organisms obtained from the throats of non-contacts; (3) a comparison between the cerebro-spinal strains and the throat strains.

Prior to the outbreak of the epidemic in this country towards the end of 1914, many investigators have worked on the meningococcus and have recorded their results in various scientific publications. As much of their laboratory data has an important bearing on the present enquiry, I have collected and reviewed the matter which seems to me of main importance in connection with the work done in the Board's Laboratory.

Historical Survey.

It is not necessary to revert to the earlier literature, written when the diplococcus of Weichselbaum was on its trial. I commence with the year 1906, when the causal relationship of this organism to cerebro-spinal fever was fully established, and its cultural characters had been thoroughly worked out. It will be convenient to dispose of fermentation tests before entering into the more complicated subject of serum reactions.

Fermentation Tests.

Lingelsheim (1906)* made a thorough investigation of the use of fermentation reactions as a means of distinguishing meningococci from other Gram-negative diplococci found in the nasopharynx. He used solid media (ascitic agar) containing 1 per cent. of the substance to be tested. This had previously been sterilised in 10 per cent. solution with Kubel-Tiemann litmus and was added to the ascitic agar just before pouring the medium. He found that meningococci produced an acid reaction in the media containing dextrose and maltose, but gave no evidence of the formation of free acid in media containing laevulose, galactose, mannite, dulcite, saccharose, lactose, or inulin. These results he confirmed with 83 strains of meningococci; they all behaved in the same way, and the fermentation with dextrose and maltose was invariably well marked.

Buchanan (1907)† used for his fermentation tests a solidified medium composed of 3 parts ox-blood serum, 1 part bouillon, with 1 per cent. of glucose, galactose, maltose, and saccharose, respectively, 1 in 10,000 of neutral red being added as indicator. He examined the throats of contacts during the Glasgow epidemic and obtained 81 positive cases (26·3 per cent.). Cultures from each of these were tested on the sugar media and gave, in every case, an acid formation with glucose and maltose, but never with saccharose. On several occasions a slight amount of acid production was observed in the galactose tube, but, he states, "this reaction is so trivial and so seldom met with that the meningococcus may be held as giving a negative reaction with galactose in this medium." He adds that in a fluid medium, containing galactose and ascitic fluid, an acid reaction has been found after an interval of several days. He noted that in his solid glucose and maltose media the meningococcus turned the water of condensation a bright yellow colour with a greenish

* Klin. Jahrb. Bd. 15.

† Transactions of International Congress on Hygiene and Demography at Berlin, September, 1907. Bd. IV.

fluorescence and a yellow, pus-like deposit at the bottom of the tube. These features he regarded as characteristic. In his table comparing the meningococcus with other varieties of Gram-negative diplococci found in the naso-pharynx, one of the latter (No. 4) is stated to agree with the meningococcus in fermenting glucose and maltose alone and in not growing at 23°–25° C., but to differ in the following respects:—(1) on glucose and maltose tubes, "growth at first resembles meningococcus, but in 48 hours the medium becomes reddened throughout"; (2) in plate culture, "colonies on Petri plate are smaller than meningococcus and become intensely red in centre."

Gordon (1907)* recommended, for the study of the fermentation reactions, a Lemco-peptone medium containing 1 per cent. of the required carbohydrate; to this, after sterilisation, a little sterile raw ascitic fluid was added before inoculation. The meningococcus, he found, was characterised by producing an acid reaction with glucose, galactose, and maltose, but not with saccharose.

Arkwright (1907)† employed liquid media for the purpose of fermentation tests and found that the characteristics of the meningococcus were "the production of acid from maltose and usually from glucose, galactose, and laevulose, but not from cane sugar."

Shennan and W. T. Ritchie (1908)‡ studied the fermentation reactions of 19 strains of meningococci obtained from cerebro-spinal fluid, using solid media prepared after the method of Lingelsheim. Acid production was always observed with glucose and maltose and, in 5 instances, with dextrin; the reactions were negative with galactose, laevulose, cane sugar, lactose, dulcite, mannite, inulin, and raffinose. The authors found that the alkalinity of their media should be very slight, as slight increase of alkalinity might prevent the appearance of an acid reaction. Two of their strains, though giving distinct reactions with maltose, gave comparatively slight reactions with glucose. Comparing liquid with solid media (parovarian broth with parovarian agar), they found that when galactose was added, 7 of their strains produced acid in the liquid medium, but not in the solid.

Mayer (1909)§ used Lingelsheim's solid media for his fermentation tests of a large number of naso-pharyngeal and cerebro-spinal strains which he investigated during the occurrence of cerebro-spinal fever at Würzburg. All his strains of undoubted meningococci agreed in fermenting glucose and maltose only; saccharose, lactose, levulose, and galactose being negative. They produced a well marked reddening of the medium with maltose, but only a slight reddening with glucose. Three strains, not classed as meningococci, are of interest in that the reddening

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* Report to the Local Government Board on the Micrococcus of Cerebro-Spinal Meningitis and its Identification.

† Journ. of Hyg. Vol. 7, p. 145.

‡ Journ. of Path. and Bact. Vol. 12, p. 456.

§ Centrbl. f. Bakt. Orig. Bd. xlix.

with glucose was well marked, while in all other cultural respects they were practically identical with meningococci. Apparently they are excluded from this class because one of them was only agglutinated up to 1 : 250 with the Höchst meningococcus serum, and the other two were not agglutinated above 1 : 100; whereas the undoubted meningococci were agglutinated up to 1 : 500. A fourth strain also bore a close cultural resemblance to the meningococcus, but differed in that with maltose, as well as with glucose, the reddening of the medium was only slight. This strain gave an agglutination with the Höchst serum in 1 : 100.

When, instead of using Lingelsheim's medium (ascitic agar), he added the litmus-sugar solution to Kutscher's agar medium, which is made with broth prepared from human placenta and contains ox serum in place of ascitic fluid, he obtained the most confusing results. Testing five strains which gave what he regarded as the typical reactions of the meningococcus on Lingelsheim's media, he found that one gave no evidence of acid formation with any of the four sugars—glucose, maltose, galactose, lactose; one produced acid with maltose only; the remaining three produced slight acid with all four sugars. He thought this difference might be attributable to the presence of dissolved red blood corpuscles in the medium.

Arkwright (1909)* preferred fluid to solid media for fermentation tests, as he found that the change with the latter, though usually more rapid, was in many instances of a very transient character. Testing 36 strains in weak broth with the addition of serum and one or other of the sugars—glucose, maltose, laevulose, and saccharose, he found that 17 fermented the first three, 15 the first two only, 1 glucose and laevulose, 1 maltose only, and two fermented none of the sugars.

Symmers and Wilson (1909)† applied fermentation tests to strains of meningococci obtained during the Belfast epidemic. using the fluid medium recommended by Gordon. They found that glucose, maltose and dextrin always produced acid and that all the other substances employed, including galactose and laevulose, failed to do so. 53 strains were tested with galactose and 43 with laevulose.

Elser and Huntoon (1909)‡ went very fully into the fermentation reactions of meningococci. They used Kahlbaum's and Merck's guaranteed pure products of dextrose, galactose, laevulose, lactose, maltose, saccharose, mannite, dulcite, inulin, and dextrin. These were sterilised in 10 per cent. solution and then added in requisite quantity to the media. Various liquid media were tried, but though these furnished "reliable data concerning the fermentative capacities," they were not recommended, because failure to grow was common. They therefore adopted for routine use Lingelsheim's method of using solid media, with a basis of ascitic agar, but tubed their medium instead of plating it. Two hundred strains of meningococci were tested

* Journ. of Hyg. Vol. 9, p. 104.
† Journ. of Hyg. Vol. 9, p. 9.
‡ Journ. of Med. Research. Vol. 20, p. 377.

and were found to agree in fermenting dextrose and maltose only. They were aware that some observers, using liquid media, found that, in addition to these two sugars, one or other of the products, laevulose, galactose, and dextrin might also give rise to an acid reaction. Laevulose and galactose, they showed by experiment, are particularly liable to be altered by sterilisation, and they quote Maquenne, who found that so-called chemically pure dextrin contains maltose, iso-maltose, or glucose in small quantities.

With liquid media the acid reaction produced by glucose and maltose usually required 48 hours to develop, and sometimes 72 hours, but with solid media it was usually apparent within 24 hours. Some quantitative determinations of acid production with these two substances were made and it was found that "the general average acid production is greater in maltose media than in dextrose media, a fact which was also observed in connection with the qualitative tests." But with a few of their strains dextrose produced more acid than maltose.

Blair Martin (1910)* compared the fermentation reactions of the meningococcus and the gonococcus, using solid culture media. He found that all his strains of meningococci, 31 in number, agreed in producing acid with maltose and dextrose, and in failing to do so with laevulose and saccharose. He noted that some of his strains of meningococci fermented dextrose less rapidly than maltose.

Conclusions as to Fermentation Tests.

Lingelsheim deserves the credit of having shown that litmus-ascitic-agar is a thoroughly reliable medium as the basis for these tests, and that, on this medium, the meningococcus produces free acid with both glucose and maltose, but not with laevulose, galactose, mannite, dulcite, saccharose, lactose, or inulin. These results have now been corroborated on a large scale by many independent observers and must be accepted as accurate. Care must, of course, be taken in the preparation of the medium; the meningococcus is a somewhat feeble acid producer and if the medium be too alkaline the reaction may be masked. Another point to bear in mind is that occasionally, though rarely, a strain is found which does not give these reactions until it has been in subculture for some time.

As regards the comparative intensities of the reactions in the glucose and the maltose media, it is interesting to note that some observers have found the reaction equally well marked with both; others that more acid is liberated with maltose than with glucose; and others, again, that with the majority of strains maltose gives more acid than glucose, but that with some the reverse is true.

Several of the observers who have placed reliance on solid media have shown that when liquid media are used some differences may be found, the most noteworthy being the production of acid with galactose. Elser and Huntoon, in particular, have

* Journ. of Path. and Bact. Vol. 15, p. 76.

done valuable service in clearing up apparent discrepancies between the results obtained with liquid and with solid media by demonstrating that certain of the sugars, especially laevulose and galactose, are, when sterilised in liquid media, especially liable to modifications which enable the meningococcus to form acid from them.

As regards Buchanan's solid medium, in the report which I have quoted he apparently excludes certain strains from the class of genuine meningococci for the one reason that they produce with glucose and maltose a more intensely acid reaction than the genuine meningococcus. This is an interesting observation, but the exclusion obviously requires confirmation by more specific tests.

Serum Reactions.

Lingelsheim (1906)* tested the agglutinability of a large number of strains of meningococci which he had collected during the epidemic in Upper Silesia in the winter of 1904–5.

His strains were obtained partly from cerebro-spinal fluid and partly from pharyngeal swabs. He employed the macroscopic method, using 1 c.c. of fluid, in which one normal loopful of culture was emulsified, and incubated his dilutions for 20 hours at 37° C. In the course of his work he found that several circumstances affected the agglutinability of the same strain with the same serum. When a culture was emulsified and tested at once, without preliminary treatment of any kind, it showed much less agglutinability than it did when the emulsion had been kept, at room temperature, for some time. This effect of storage was not confined to a particular strain, but was found to be a general rule. During the first three to four weeks of storage, the agglutinability was unstable, but after the fourth week it became constant and then remained unchanged to the end of the sixth month. Compared with its agglutinability when tested in the fresh condition, the agglutinability of a culture emulsion which had been kept until it became constant was increased about five times. The emulsions were made from ascitic agar cultures with ·9 per cent. saline solution, ·1 c.c. of formalin being added to 40 c.c. of saline. Lingelsheim also investigated the influence of heat on the agglutinability of fresh cultures and found that exposure for ½–1 hour to temperatures of 50° C., 60° C., and 70° C. increased agglutinability but 80° C. had the reverse effect.

He prepared two rabbit sera. The first, produced with a strain of meningococci obtained by lumbar puncture, gave a titre of 1:400. Sixty-three strains were tested with it, the majority being cultures from the pharynx; they were all agglutinated in dilutions of from 1:200 to 1:400, whilst none were agglutinated in 1:10 by normal rabbit serum. The second serum, produced by another strain of meningococci obtained by lumbar puncture, gave a titre of 1:800 and was tested on 47 strains. These agglutinated between 1:400 and 1:800, but were not agglutinated by normal rabbit serum in 1:10.

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* Klin. Jahrb. Bd. xv.

With regard to the identification of Gram-negative diplococci obtained from the naso-pharynx, Lingelsheim remarked that resort to agglutination was not usually necessary, provided that careful attention was paid to cultural and fermentation tests, but he added that *flavus* No. 3 might give trouble, if only slightly pigmented, and then might have to be differentiated by agglutination.*

In a footnote, however, he appended a further qualification to this general statement. He said he was aware that from the throats of healthy persons strains were sometimes obtained which, though corresponding in all other respects with meningococci, failed to give a specific agglutination reaction. Whether such strains should be regarded as "pseudo-meningococci" must, he considered, be left for future research to determine.

Kutscher (1906),† in view of the discovery of the meningococcus in the throats of persons in contact with cerebro-spinal fever, thought it desirable to make control investigations upon the throats of non-contacts. At Berlin, during May and June, 1905, he examined swabs from the naso-pharynx of 104 persons, about half of whom were children. They had not been in contact with the disease and were examined at a time when cerebro-spinal fever was not present in Berlin in epidemic form. All of these failed to yield cultures of the meningococcus, though at the same time the specific organism was obtained from the throats of two persons who had been in contact with sporadic cases of the disease. As these negative results were obtained at a season of the year unfavourable for the production of catarrhal conditions, there was the possibility that the bacterial flora of the naso-pharynx might be different in the winter. So he continued his investigation of non-contacts in December, 1905, and January, 1906, when Berlin had remained completely free from both epidemic and sporadic cerebro-spinal fever for a period of six months. He swabbed 56 patients suffering from slight catarrhal affections of the upper respiratory tract, and found that 52 were negative, but cultures from four were indistinguishable from the meningococcus "morphologically, culturally, and in their immunity reactions."

For his agglutination tests he employed a powerful anti-meningococcus horse serum, using the macroscopic method. The dilutions were incubated at 37° C. for 24 hours, and controls were made with normal horse serum and with saline. His four throat strains and five cerebro-spinal fluid strains obtained from the epidemic in Upper Silesia were tested, with the result that well-marked agglutination was obtained with all, the throat strains being as highly agglutinable as the strains of undoubted meningococci. As regards the significance of these agglutination tests, he remarked that, in considering results with meningococci, as with other species of cocci, agglutination in low dilution

* In a later article (1908) (Zeitschr. f. Hyg., Bd. 59) he said that all three varieties of *flavus* were distinguishable from meningococci by fermenting laevulose in addition to glucose and maltose.

† Deutsch. med. Wochschr., 1906, Nr. 27, S. 1071.

only must be taken with reserve, but agglutination in higher dilutions, such as he obtained in this case (1:200, 1:500, and sometimes 1:1,000), must be regarded as "a link in the chain of proof." It must also be remembered, he added, that some strains of meningococci, like some strains of staphylococci, are only agglutinated with difficulty or are almost inagglutinable.

He also tested the above throat and cerebro-spinal strains as regards absorption of agglutinin. To 10 c.c. of a 1:20 dilution of the serum he added three cultures (24 hours' growth) and incubated at 37° C. for one hour, the absorption being facilitated by shaking. The clear liquid obtained by centrifuging was then tested, controls being made with unabsorbed serum, saline, and normal horse serum. He found that different strains behaved differently. When the serum was absorbed with a cerebro-spinal strain, agglutinin was almost completely lost for some cerebro-spinal and some throat strains, but remained effective, even in high dilution, for one throat and two cerebro-spinal strains. When saturation was made with a throat strain, there was again loss of agglutinin for some cerebro-spinal and throat strains and retention of it for others, but, as regards the action on individual strains, the changes effected were not identical with those produced in the former experiment. So specific absorption experiments afforded no evidence that his throat strains were distinguishable from meningococci. Meningococci, he remarked, resembled the organisms of cholera, typhoid and paratyphoid, in that different strains, when tested with the same serum under identical conditions, exhibited different degrees of capacity for combination with agglutinin.

After his experiments had reached this stage, two of his throat strains were accidentally allowed to die out. With the two remaining, further investigations were conducted. Tested by Lingelsheim's recently published (1906) method of using carbohydrate media for differential diagnosis, they conformed with the author's criterion for the meningococcus. Deviation of complement experiments made with these two strains and with strains of undoubted meningococci showed that the former prevented haemolysis in as high a degree as the latter. Rabbit sera prepared with the two throat strains agglutinated a cerebro-spinal strain of meningococci, but he had not had sufficient time, when this report was issued, to prepare very strong sera.

His conclusion was that the identity of his throat strains with the meningococcus had been definitely established in the case of the last two, and had been brought to a high degree of probability in the case of the two which died out before the work was concluded.

Hübener and Kutscher (1907)* following up Kutscher's work on the "normal carrier," examined 400 soldiers in a regiment which was free from cerebro-spinal fever, and in the throats of eight found cocci which were identical with the meningococcus in every bacteriological respect, including immunity

* Deutsche militärärztl. Ztschr. 1907. No. 15. Quoted in Centrbl. f. Bakt. Ref. Bd. 42.

reactions. The eight men had not been in individual contact with each other. Several months previously their regiment had been quartered, elsewhere, with a regiment in which cerebro-spinal fever had occurred.

Eberle (1908)* tested the agglutinability of 18 strains of meningococci, all of which had been obtained from cerebro-spinal fluid during life. He used five sera, viz., the Berne, Berlin, and Merck horse sera, and two monovalent rabbit sera. He adopted the macroscopic method and made his suspensions with stored emulsions to which phenol had been added. After making parallel experiments at room temperature, 37° C., and 56° C., he gave up the first, because he found that the reactions were slower, more uncertain, and did not attain to such high dilutions as with the higher temperatures. Investigating the time requisite for the reactions, he found that two hours was useless, and that incubation overnight was necessary; eventually he decided to take his readings at the end of two days, as he noted that 24 hours was not long enough; the maximum agglutination required 38–42 hours to develop.

Marked differences were found between the agglutinability of different strains when tested with the same serum, some strains reaching up to 1:1,000 and others only up to 1:20 or 1:50. It was also noted that individual strains did not behave uniformly towards different sera. His 18 strains could roughly be divided into good, rather poor, and poor agglutinators. The last, which for the most part had been recently recovered from patients, did not agglutinate with any of the sera higher than 1:50. Good agglutinators would attain reactions in dilutions varying from 1:1,000 with one serum to 1:100 with other sera. When the tests with the same strain and serum were repeated at different times a general conformity of results was observed. The monovalent rabbit sera did not show a distinctive difference in agglutinability as between the homologous and the heterologous strains; the more readily agglutinated strains were agglutinated as highly as, or even more highly than, the homologous strain.

Eberle concludes by saying that the identification of meningococci from the throat is difficult, and not made easier by agglutination tests.

Arkwright (1909)† studied the serum reactions of several strains of meningococci obtained from cases of epidemic and sporadic meningitis. In his report he designates his epidemic strains by the letter E and his sporadic strains by the letter L.

All his agglutination experiments were made by the microscopic method, at room temperature, and the observations were completed at the end of two hours.

He has recorded his tests of 25 strains with serum I., obtained from a horse which, for a period of 12 months, had

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* Arch. f. Hyg., Bd. 64.

† Journ. of Hyg. Vol. 9, p. 104.

received repeated injections, partly subcutaneous and partly intravenous, of the strain L 1. This strain was completely agglutinated up to 1:100 and partially up to 1:500, whilst normal horse serum gave no agglutination even in 1:5. Strains L 7 and and L 12 were also completely agglutinated up to 1:100; L 7 was slightly agglutinated in 1:500 and L 12 was partially agglutinated in 1:500 and slightly in 1:2,000. Of the remaining 22 strains, one, L 5, gave slight agglutination in 1:100 and also in 1:500; none of the others gave any agglutination in 1:100.

Eleven of the above 25 strains were tested with serum II. This was obtained from the same horse when, after the withdrawal of serum I., the animal had received for 10 months injections of E 12, a strain which yielded no more than partial agglutination in 1:5 to serum I. The tabulated results show that serum II. agglutinated L 1 slightly better than the former serum had done; but with its second homologous strain, E 12, there was no more than slight agglutination in 1:25. Of the remaining nine strains tested, L 7 and L 12 behaved like L 1; L 5 was now agglutinated in as high dilution as these; and another strain, E 4, now became agglutinated completely in 1:100 and slightly in higher dilutions. None of the rest gave as much as complete agglutination in 1:25.

At a later date, but without having received fresh treatment, the horse was bled again, yielding serum III. This serum differed from serum II. in that it agglutinated (complete up to 1:50) the homologous strain E 12. It also agglutinated, in equal degree, E 19, a strain negative to serum I., but not recorded as tested with serum II. In other respects the behaviour of serum III. towards the 12 strains tested showed only slight differences from sera I. and II.

Arkwright also mentioned briefly that he tested 22 of his strains with Kolle's anti-meningococcus serum and obtained agglutination with six in dilutions as high as 1: 100 or 1:200.

In a series of absorption experiments serum I. was tested with four strains which it agglutinated relatively well, viz., L 1, L 5, L 7, L 12, and with two which were not themselves agglutinated, viz., E 5 and E 7. It was found that L 1 and L 5 absorbed agglutinin for themselves and for each other, but only slightly absorbed agglutinin for L 7 and L 12. L 7 and L 12 absorbed to a certain extent their own and each other's agglutinin, but hardly any for L 1 and L 5. E 5 and E 7 absorbed no agglutinin for any of these four strains.

These results may be compared with fixation of complement experiments with serum I. Out of the four strains mentioned above, which agglutinated relatively well, fixation was complete or nearly complete with L 1, L 7, and L 12; with the fourth, L 5, it sometimes occurred and sometimes failed. Out of six strains which were recorded as only slightly agglutinable (1:5 or 1:20), one brought about complete, or nearly complete, deviation; the others failed.

Incidentally, on comparing Arkwright's tables, there is evidence that when the same strain was tested with serum I. on

different occasions the results did not always correspond precisely. For example, out of seven tests with L 12, the result on two occasions was complete agglutination up to 1:200 and slight up to 1:500; but on another occasion the agglutination was only slight in 1:100 and only partial in 1:20 and 1:50.

In his "conclusions" Arkwright states that "the variations observed in the sugar and serum reactions were not such as to indicate a specific difference between the epidemic and sporadic strains, for the differences between individual members of each group were as great as any found between the two groups."

Elser and Huntoon (1909)* worked for the commission appointed by the Health Board of New York in March, 1905, to investigate cerebro-spinal meningitis. After presenting an epitome of their work in January, 1906, they proceeded to further study of serum reactions and issued their final report in 1909. The majority of the strains of meningococci which they examined were obtained from cerebro-spinal fluid or meningeal exudate; they also report on other cocci of interest, which were isolated from the respiratory passages in cases of meningitis, or from persons who had come in more or less close contact with such cases.

They prepared agglutinating sera by inoculating rabbits intravenously with weekly doses of meningococci suspended in saline solution and killed by heating at 65° C. for 30 minutes. The initial dose was usually ·002 gm.; this was gradually increased to ·008 gm. They relied entirely on the macroscopic method of examination, as preliminary tests with the microscopic method had been found less satisfactory. Their dilutions received, per c.c., ·004 gm. of moist cocci, measured with a standard platinum loop. The dilutions were incubated for two hours and then kept in the cold (9° C.) for 22 hours. The final reading was taken at 24 hours; preliminary readings were also usually taken at 1, 2, 3, and 4 hours. Occasionally, no appreciable change was noticed after several hours, although complete clarification was found in 24 hours. When the agglutination was not progressive with increase of time, the tests were repeated. They recorded a reaction as positive when the great majority of the cocci were clumped and deposited at the bottom of the tube, whilst the supernatant fluid presented a slight degree of turbidity when viewed obliquely in a good light. Control tests were made with normal rabbit serum. The cultures used for testing agglutinability were grown on media which did not contain serum or ascitic fluid.

In discussing their reasons for adopting the above technique, they stated that they had made a comparative study of the influence of incubator, room, and ice-box temperature on agglutination and found that, though incubator temperature hastened the reactions, the end results were not markedly influenced. They did not agree with Kutscher that agglutinability was brought to a higher level by exposure to 55° C., though it might

* Journ. of Med. Research, Vol. 20.

be accelerated. In support of these statements they have published two tables. Table X. shows agglutination tests with seven strains of meningococci at both 37° C. and 55° C., readings being taken at 1, 2, 4, and 24 hours. It is noteworthy that three of the strains were practically unaffected by the serum employed and that each of the remaining four showed more agglutination at 24 hours than at 2 hours, when incubated at 37° C. Table XI. records agglutination tests with nine strains of meningococci at temperatures of 10° C., 30° C., and 37° C., the readings being taken at 24 hours. Three of the strains were practically unaffected by the serum employed; of the remaining six, three showed most agglutination at 37° C., the remaining three were equally agglutinated at all three temperatures.

They considered it necessary to use normal rabbit serum as a control, as they found that some strains of meningococci were agglutinated by the normal serum in 1:50 and, rarely, in 1:250.

In their experience, growth on media containing serum or ascitic fluid had an unfavourable influence on agglutinability; so they waited until their cultures could be accustomed to grow without the aid of these ingredients before testing for agglutination, glucose agar being generally adopted as the most suitable medium.

They stated that "one of the great difficulties encountered in connection with this work is the very pronounced instability of the agglutinable properties of the meningococcus." When the same strains were tested on different occasions with the same sera, the results were not found to be constant. Lingelsheim, they remark, suggested that killed cultures gave better results, and in this view they agreed with him; but they have not stated to what extent or with what degree of success they followed Lingelsheim's technique. Apparently they were unable to overcome the difficulty completely, as they have again stated, in the summary of their results, that "the unusual instability of the agglutinable properties of the meningococcus" was a serious obstacle. They tried to increase agglutinability by growing their strains in glucose broth, and reported that "while several strains reacted promptly to this treatment, others were not materially altered, even after prolonged growth, and in a few there was reduction of agglutinability."

Apart from variations in the agglutinability of individual strains, they found great differences in the degree of agglutinability exhibited by different strains in the presence of the same immune serum. They tested 65 strains with a serum, prepared from their strain M 30, which gave a titre of 1:1,000. Twenty-five of these strains either failed to react at all or gave no more than incomplete reactions in 1:50. Tests have also been recorded of sera prepared from certain other strains of meningococci, and with these sera again the results showed that some strains were not agglutinated or were only agglutinated to a slight degree. Enquiring further into some of the strains which failed to agglutinate, they have reported that injection of them into rabbits produced sera which were ineffective towards the homologous strains, but were of moderate potency in agglutinat-

ing strains already found agglutinable with the sera previously mentioned. Hence they have termed the strains in question "agglutinogenic" but "inagglutinable." They admitted that this latter term was not absolutely accurate, because, though some of the strains failed to agglutinate even in 1 : 10, others were agglutinable up to 1 : 50; but they found it convenient to define as "inagglutinable" all strains which failed to react to powerful sera in 1 : 100. They remarked that they were unable to render an inagglutinable strain more sensitive by conducting the experiment at a temperature of 55° C.

Proceeding to absorption experiments, Elser and Huntoon called special attention to their technique. "Instead of exhausting a serum with large and variable quantities of bacteria, each serum was absorbed with small and constant amounts in the hope of detecting slight differences in the absorptive capacities of different strains belonging to the same species." The suspension of cocci was ·004 gm. per c.c., and was mixed with equal parts of diluted serum. Two control tubes received the same amount of diluted serum and equal parts of saline. The tubes were incubated for 2 hours. Preliminary tests showed that the maximum absorption was attained within this time; no more was obtained in 24 hours. Their attention was called to the condition of the contents of the tubes after centrifuging. The agglutinable homologous cultures were firmly packed at the bottom; the fluid was perfectly clear, and vigorous shaking failed to re-establish a perfect suspension. But the heterologous strains and the inagglutinable homologous strains were less firmly packed; the supernatant fluid was not quite clear; and vigorous shaking produced a perfect suspension.

They found that the inagglutinable strains were capable of absorption, to a certain extent, and, in general, that the binding capacity of these corresponded with their agglutinogenic capacity. There was, however, one exception. A certain inagglutinable strain was found to have no power of absorption with the serum produced from it, though this serum was capable of agglutinating one strain up to 1 : 1,000. No definite relationship could be established between absorptive capacities and agglutinability. They have quoted, for example, an instance where an inagglutinable strain absorbed as much as an agglutinable one.

In summary of the above, a large number of strains, though undoubtedly meningococci, were more or less inagglutinable by the sera with which they were tested. The authors have made no definite statement as to the number of these strains which produced sera capable of agglutinating other meningococci but incapable of agglutinating the homologous strain.

They have recorded, however, an experiment with five strains—two "agglutinable" and three "inagglutinable." With regard to two of the three latter, they have noted that they "were inagglutinable when first selected for the present purpose, but subsequently reacted to certain immune sera in dilutions of 1 : 100." With each of the five strains one rabbit was immunised. The sera from the five rabbits were tested against 18 strains, the result being that all five sera "affected agglutinable meningo-

coccus strains in fairly high dilutions." Taking the results which did not attain to a positive reaction in 1: 100—with the serum prepared from one of the agglutinable strains, only two of the 18 strains failed to reach this standard; with the serum prepared from the second agglutinable strain, 11 strains failed to reach the same standard; with the sera produced by the three "inagglutinable" strains, the numbers of strains which fell short of this standard were, respectively, 8, 11, and 12.

In this same experiment with the sera of five rabbits, each immunised with a different strain, the maximum reactions of the three "inagglutinable" strains towards these five sera were:—

Cultures.	Sera prepared with the				
	Agglutinable strains.		Inagglutinable strains.		
	M 24	M 83	M 101	M 175	M 61
M 101	0	1:100	1:25	0	0
M 175	1:25	1:100	1:25	1:100	1:50
M 61	0	1:50	0	0	0

The above are all the experimental data which I can find in support of the generalised statement as regards the "agglutinagenic" capacities of their "inagglutinable" strains, which the authors make in their "conclusions." This statement is that "towards the homologous inagglutinable strains they were ineffective."[1]

With regard to their Gram-negative diplococci, other than those regarded by them as meningococci, they found that all except six strains could be differentiated from the meningococcus by means of cultural and fermentation tests. These six, which they term "pseudo-meningococci," agreed with the meningococcus in their cultural and fermentation tests, but differed in their serum reactions. They were not agglutinated with a meningococcus serum, and were found incapable of abstracting specific agglutinin from it. They found their pseudo-meningococci more toxic for rabbits than meningococci; many succumbed to very small doses. They succeeded, however, in producing a serum (titre 1:500) with one strain. This serum did not agglutinate any of the other five strains of pseudo-meningococci; nor did it agglutinate strains of meningococci in higher dilution than did normal serum. Normal rabbit serum agglutinated the strain used for producing the immune serum up to 1: 50, and a strain of meningococci (M 250) up to 1: 100. In a series of absorption experiments with its own strain this "pseudo-meningococcus" serum lost the agglutinin to its homologous strain, but not to M 250.

Mayer (1909)* tested, with the Höchst serum, the agglutinating properties of various strains, including undoubted meningococci and organisms, obtained from the naso-pharynx, which presented certain resemblances to these. No statement is made as to how this serum was prepared. Mayer used both the macroscopic and the microscopic methods of examination. His dilutions were kept for 12 hours at 37·5° C. before the final reading. He attached particular importance to exposure to this temperature for at least 12 hours, and has recorded experiments showing that, when the readings were taken successively at 1, 2, 3, 6, and 12 hours, standard strains did not give definite agglutination in high dilution (1:500) before the 12 hours' period was reached.

His standard strains of undoubted meningococci were four in number. One was obtained from Ruppel and one from Weichselbaum; the other two, designated M. 1 and W. 1, were cultured by Mayer from lumbar puncture fluid. These four all gave definite agglutination with the Höchst serum up to 1:500; and they were all identical morphologically, in their mode of growth with various media, and in fermentation tests.

With these four strains he compared his throat strains, which he had collected in the course of an examination of 251 persons.

Of these throat strains, thirteen, all derived from the throats of infected persons or carriers, agreed in every respect with his standard strains. Fifteen other throat strains corresponded with his standard strains in all respects except agglutination; with his Höchst serum they were either not definitely agglutinated in any dilution or at least not in a dilution as high as 1:500. These strains he has called "pseudo-meningococci." The remaining throat strains could be excluded from the class of meningococci without resort to agglutination tests.

He stated that amongst normal individuals, who had not been in contact with cerebro-spinal fever and were examined at a time when this disease was not prevalent, cocci might be found in the throat which could only be distinguished from meningococci by the agglutination test. He maintained that such strains could not be regarded as meningococci unless they gave a positive reaction up to 1:500.

Friese and Muller (1909)† found cocci closely resembling meningococci in the throats of persons who had not been associated with cases of cerebro-spinal fever. They were led to this discovery whilst investigating, at Beuthen, an outbreak amongst the troops which was regarded as influenza. These cocci were found in 28 out of 36 soldiers affected with this epidemic. Then 60 normal soldiers were taken as controls, and similar cocci were found in the throats of 28 of these. In some cases the cocci were abundant, in others only moderately numerous, and, in others, scanty. By microscopic methods and cultural tests, including fermentation tests, they were unable to distinguish them from meningococci. They therefore resorted to agglutination tests

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* Centr. f. Bakt., Heft. I., Orig., Bd. xlix.

† Klin. Jahrb., Bd. 20.

and, on the strength of the results obtained by this method, designated these cocci as pseudo-meningococci or "S. cocci."

In their agglutination work they employed the macroscopic methods and used 48 hours' cultures grown on slightly alkaline ascitic agar. They used cultures of this age because Lingelsheim had observed that such cultures agglutinated better than 24 hours' growths. The serum used was Merck's polyvalent horse serum, giving a titre of 1:600 with good agglutinating strains of undoubted meningococci. Their dilutions were treated in one of two ways:—(1) incubation at 37° C., preliminary reading at 24 hours, final reading at 48 hours; (2) incubation at 55° C., final reading at 24 hours.

They found that the latter method gave sharper distinctions between their "S. cocci" and undoubted meningococci. Out of 21 "S." strains tested at 55° C., only one gave a complete reaction in 1:100; whilst, out of 16 strains of true meningococci, 12 gave a complete and 4 a partial reaction in 1:200.

They also made comparative tests with a rabbit serum prepared from "S. cocci." This had been prepared with a single strain, and the fact that it was not polyvalent they found to be a disadvantage. With this serum, again, a temperature of 55° C. brought out sharper differences than 37° C. Twenty-three "S." strains were tested at 55° C.; six gave complete reactions up to 1:400, and with four others the reaction was complete up to 1:200. On making parallel tests with 13 strains of true meningococci it was found that none gave complete reactions in 1:200 and only three were complete in 1:100.

The above data illustrate the point on which Friese and Müller have laid chief emphasis, viz., the differences between their "S. cocci" and the strains of undoubted meningococci with which these were compared. At the same time they admitted that there was a relationship between "S. cocci" and true meningococci, and they considered that this relationship was shown more strongly by some strains than by others. They also found that the agglutination reactions both of their "S. cocci" and their true meningococci were liable to some degree of variation.

The following statements in their report require mention, as they have a bearing on the question whether the authors' distinction between "S. cocci" and true meningococci can be accepted without qualification.

(1) They have reported that their earliest strains of "S. cocci" agglutinated better than all the later ones and at first seemed undoubted meningococci. But unfortunately these strains died out, and as they could not be included in their comparative tests, the data as regards their agglutinability could not be ascertained.

(2) A large number of their strains, both "S. cocci" and undoubted meningococci were tested on two or three different occasions against the same serum. Frequently the results obtained on different occasions with the same strain did not correspond closely; and sometimes the difference was great. For example, on June 1st, an "S." strain gave a completely negative result with Merck's anti-meningococcus serum; but

on July 10th, though the control test with normal serum was again completely negative, a complete agglutination up to 1:100 was obtained, and there was a slight reaction in 1:200. These variations in agglutinability they were unable to explain. They found them to be greater with "S. cocci" than with undoubted meningococci.

(3) Several of the "S." strains which, at 37° C., gave complete agglutination in 1:100 with Merck's anti-meningococcus serum, also gave some agglutination with normal horse serum.

(4) Although the majority of their meningococci agglutinated well with the Merck serum, a few did not.

(5) In the course of their endeavours to prepare an "S." serum in rabbits, they found that, though the homologous strain was only agglutinated to a slight degree, several strains of meningococci were agglutinated more strongly.

(6) Reference has already been made to agglutination tests at 55° C. with a rabbit serum prepared from a strain of "S. cocci." This serum was also tested at 37° C. It agglutinated the homologous strain completely up to 1:800. But, out of 19 other "S." strains which were tested only one gave complete agglutination up to 1:200; whereas, in parallel tests with 11 strains of undoubted meningococci, three gave complete reactions in 1:200. Of these three, two agglutinated well with Merck's anti-meningococcus serum, but one was completely negative.

(7) Absorption experiments at 37° C. (48 hours' reading) with three "S." strains and three strains of meningococci. Merck's serum, after saturation with one of the latter strains, lost all agglutinin, beyond 1:50, for these three strains; but when the serum was saturated with an "S." strain the same three strains of meningococci gave complete reactions up to 1:200 and partial up to 1:400. An "S." serum, after saturation with a strain of meningococci, gave only slight agglutination with the meningococci and the "S.". strains; when the serum had been saturated with an "S." strain, it gave rather more agglutination with strains of meningococci, but none with "S." strains.

(8) Absorption experiments at 55° C. (24 hours' reading) with five strains of meningococci and five strains of "S." cocci. Saturation of "S." serum with meningococci removed agglutinin for meningococci, but not for "S." strains; whilst saturation of the serum with "S." cocci removed agglutinin for both types.

Lieberknecht (1909)* examined at Posen the throats of 150 healthy school children, not known to have been in contact with cases of meningitis, and found meningococcus-like colonies in cultures from 8 per cent. In culture tests, including fermentation tests, for which he used Lingelsheim's media, they behaved like meningococci. He then proceeded to examine the serum reactions of these cocci, and to compare them with the reactions of undoubted meningococci. He used cultures not over

* Arch. f. Hyg., Bd. 68.

24 hours old, and adopted the macroscopic method. He incubated one sample of each dilution at 37° C., and a second at 55° C. In each case he took the final readings at 24 hours.

Thirteen throat strains were tested with a Berlin meningococcus serum (titre 1:1,000). Except with two strains, the reactions, when positive at all, were better at 55° C. than at 37° C. Taking the reactions at 55° C. only:—In 1: 100, 6 strains were negative, 3 gave slight, 2 partial, and 2 complete reactions; at 1:200, 8 were negative, 3 gave slight, 1 a partial, and 1 a complete reaction. None of the strains were agglutinated by normal rabbit serum in 1: 10.

He made similar tests with the same serum applied to 12 strains of undoubted meningococci. Here again, with slight exceptions, the reactions were rather better at 55° C. than at 37° C. Taking the reactions at 55° C. only:—In 1:100, 1 strain was negative, 2 gave slight, 1 a partial, and 8 complete reactions; at 1:200, a second strain also was negative, 4 gave slight, 3 partial, and 3 complete reactions. These last 3 also gave complete reactions in 1:400.

Lieberknecht prepared a rabbit serum with one of his throat cultures, giving repeated subcutaneous doses of living cocci in increasing amount. He has tabulated the effects of this serum on the homologous strain and 10 other throat strains at 37° C. (reading at 24 hours). The homologous strain was completely agglutinated in 1:200, and partially or slightly up to 1:600. Two other strains behaved similarly; the 8 remaining strains were negative in 1:100.

He tested the same serum with 10 strains of undoubted meningococci, and has tabulated, in this case, the 24 hours' readings at both 37° C. and 55° C. Six strains, he noted, were agglutinated better at 55° C. than at 37° C. Taking only the reactions recorded as complete:—At 1:600, one strain was complete at 55° C., but not at 37° C.; at 1:400, the same strain was complete at both temperatures; at 1:200, a second strain was complete at 55° C. but not at 37° C., and a third strain was complete at 37° C. but not at 55° C.; at 1:100, this third strain was again complete at 37° C., but not at 55° C., the second strain was complete at both temperatures, a fourth and a fifth strain were complete at 55° C., but not at 37° C. Taking evidence of agglutination, whether complete or incomplete, 1 strain showed evidence up to 1:100, 3 up to 1:200, 2 up to 1:400, and 2 up to 1:600.

Lieberknecht has also made brief mention of some absorption experiments. Taking a specific meningococcus serum and saturating this for one hour at 37° C., with one loopful of culture to 1 c.c. of 1: 20 dilution of serum, he found that a genuine meningococcus culture removed specific agglutinin, but all his throat cultures failed to do so. He has called particular attention to the fact that the throat strain which produced the rabbit serum, mentioned above, did not absorb the agglutinin for meningococci present in his meningococcus serum.

Dopter (1909)* found certain organisms which he called "para-

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* C. R. Soc. de Biol., July, 1909.

meningococci" in the naso-pharynx of persons who had been in contact with cases of cerebro-spinal fever. Though agreeing with true meningococci in ordinary cultural and fermentation tests, he excluded them from this group owing to certain differences brought out by serological tests. They did not give specific agglutination with a meningococcus serum and failed to respond to the absorption test for specific precipitins. They agreed with meningococci, however, in fixation of complement tests. Though calling them "para-meningococci," he considered them to be nearly allied to meningococci, and advised that, from the practical point of view, persons in whose throats they were found should be treated as carriers of the meningococcus.

Mayer, Waldmann, Furst and Gruber (1910)* have stated that, at a time when cases of cerebro-spinal fever were found, they examined, in various garrisons, the throats of 1,911 healthy persons, and found 47 (2·46 per cent.) to be carriers. None of these developed the disease. They controlled these results by examining garrisons at Munich in 1910, when there was no cerebro-spinal fever. They swabbed the throats of 9,111 men, and found 158 carriers (1·73 per cent.). None of these developed cerebro-spinal fever.

They concluded that the meningococcus must be regarded, for practical purposes, as ubiquitous, and that bacteriological examination of throats was impracticable as a useful aid to prophylaxis in time of epidemic.

Sachs-Muke (1911)† enquired at Beuthen, in the winter months of the year, into the occurrence of meningococci and pseudo-meningococci in the naso-pharynx of normal persons. Out of 202 soldiers, none of whom were associated with cerebro-spinal fever, he found no carriers of true meningococci, but 15 carriers of pseudo-meningococci or "S." cocci. There was no evidence that these carriers had infected each other, as they were widely distributed in different quarters. The "S." coccus was obtained also from the throat of 1 out of 28 civilians, not associated with cerebro-spinal infection. He also took the opportunity, at the same time of the year, of examining the throats of a batch of recruits newly arived from other parts of the country. In none of these did he find either genuine meningococci or "S." cocci.

The "S." cocci fermented dextrose and maltose, but never laevulose; and in the other routine cultural tests they were indistinguishable from true meningococci, though perhaps the outline of the primary colonies was less sharply circular, and there were fewer tetrads. Differentiation was effected by serological reactions, upon which he proceeded to report.

His agglutination tests may be summarised as follows:—

I. (*a*). Agglutination tests at 37° C.; reading at 48 hours. Sixteen "S." strains tested with Merck's polyvalent meningococcus serum (titre 1:600). The total number of tests was 35, many strains being tested twice or oftener. The results of different

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* Munch. med. Wochschr., July 26th, 1910.

† Klin. Jahrb., Bd. 24, p. 225 and p. 451.

tests with the same strain did not always coincide precisely. In all the 35 tests some reaction was obtained in 1:100, the controls being all negative, and in all except 6 tests the reaction was complete in 1:100. At 1:200, only six of the 35 tests were negative; and, in this dilution, six strains were completely positive on at least one occasion. At 1:400 no test gave more than a partial reaction; and, in this dilution, 14 of the tests were completely negative.

1. (*b*.) Agglutination tests at 55° C.; reading at 48 hours. The same strains and the same serum as in I (*a*). At 1: 100, none of the tests was completely positive, but 11 out of the total 36 tests gave a partial reaction. At 1:200 all the tests were negative.

II. (*a*) Agglutination tests at 37° C.; reading at 48 hours. Twenty strains of meningococci tested with Merck's polyvalent meningococcus serum. The total number of tests was 48. At 1:100, only one test was negative; this was with strain 13; this strain was tested twice; on the second occasion it gave a complete reaction in 1:100. At 1:200 all the tests were completely positive, except 3, viz., the two tests with strain 13, which were completely negative, and one of the two tests with another strain, which gave a partial reaction. At 1:400 there were 10 completely negative and two partial results, all the remaining tests being completely positive.

II. (*b*). Agglutination tests at 55° C.; reading at 24 hours. The same strains and the same serum as in II (*a*). Strain 13 was negative as before (three tests). All the other tests gave completely positive reactions in 1:400.

III. (*a*). Agglutination tests at 37° C.; reading at 48 hours. Seventeen "S." strains tested with the Beuthen Institute's polyvalent "S." serum. Total number of tests, 30. At 1:100 every test gave some reaction, and all except four were complete; each strain gave at least one complete reaction. At 1:200 every test gave some reaction, but six were incomplete, viz., the four which were incomplete at 1: 100 and two others. At 1: 400, 16 tests were completely positive, five completely negative, and nine partial. Reviewing the tests as a whole, there was no consistently weak agglutination, but some little irregularity.

III. (*b*). Agglutination tests at 55° C.; reading at 24 hours. The same strains and the same serum as in III (*a*). At 1: 100 five of the 17 strains failed completely; each of the remaining 12 gave at least one completely positive reaction. At 1: 200 only six strains gave, each on one occasion, a completely positive reaction. At 1:400 there were only four completely positive reactions; and at 1:600 there was only one.

IV. (*a*). Agglutination tests at 37° C.; reading at 48 hours. Twenty strains of meningococci tested with the Institute's polyvalent "S." serum. Each strain tested twice, except one, which was tested once, and one which was tested three times. Strain 13 (see previous tests) was completely blank in both tests. The strain which was only tested once was also completely blank. One strain was completely blank in one test, but positive up to 1:100

in the second test. One strain, also completely negative in one test, was positive up to 1 : 400 in the second test. In summary :—At 1 : 200 there were 28 completely positive results, belonging to 15 strains; at 1 : 400 there were 17 completely positive results, belonging to 11 strains.

IV. (*b*). Agglutination tests at 55° C.; reading at 24 hours. The same strains and the same serum as in IV (*a*). Strain 13 was again completely blank in both tests. Eight other strains were completely blank in one test, but gave some agglutination in a second; in one of these instances the agglutination was complete up to 1 : 400. In summary :—At 1 : 200 there were 22 completely positive results, belonging to 13 strains; at 1 : 400 there were 10 completely positive results, belonging to six strains.

Sachs-Müke also made some absorption experiments, using Merck's polyvalent meningococcus serum (titre 1 : 600) and the Beuthen Institute polyvalent "S." serum (titre 1 : 400) against eight strains of meningococci and seven of "S." cocci. He added a 48 hours' ascitic agar culture to 5 c.c. of a 1 : 20 serum dilution. His tables show the following results :—

I. (*a*). Meningococcus serum saturated with meningococci. "S." cocci showed some incomplete agglutination at 37° C., but were completely negative at 55° C.

I. (*b*). The same serum saturated with "S." cocci. Meningococci agglutinated.

II. (*a*). "S." coccus serum saturated with "S." cocci. Meningococci agglutinated.

II. (*b*). The same serum saturated with meningococci. Agglutinins for "S." cocci not affected at 37° C., but completely removed at 55° C.

Arkwright (1911)* recorded further work on serum reactions, which he employed to compare the meningococcus with the gonococcus by the complement fixation test. In so far as the comparative reactions of different strains of meningococci are concerned, the following points in his article may be quoted.

Referring to his previous work on agglutination, he states that, "when working with a monvalent meningococcal serum, the number of strains agglutinated was very limited, and, even when a polyvalent serum of a titre of 1 : 1,000 made by injecting twelve different strains of meningococcus was employed, strains of meningococcus were easily found which were not agglutinated more highly by the specific serum than by normal serum."

In his fixation experiments he used extracts of meningococci. An emulsion of the growth on ascitic agar was made with 10 c.c. of saline. "This was centrifuged and the deposit made up to its original volume with salt solution. After adding a few drops of chloroform and shaking, the emulsion was left at room temperature for three or four days. The extract was then centrifuged before use. It was found that if the deposit from the last centrifuging was again made up to the original volume with salt solution and left for a further period of two to three days, a second extract as good as the first could be obtained,

* Journ. of Hyg., vol. xi., p. 515.

and by again repeating the same process, a third and even a fourth extract could sometimes be obtained of almost undiminished value for complement fixation experiments."

The following is a summary of his experiments with meningococcal sera and extracts:—

(1) A monovalent serum was prepared from a horse by inoculation with M 12, a culture isolated from the meninges of a sporadic case of meningitis. This serum was tested with three strains, M 119, isolated from the spinal cord of a case of acute epidemic meningitis, and M 141 and M 162, each isolated from cerebrospinal fluid of sporadic cases of meningitis. A positive complement fixation reaction was obtained with M 141; M 119 was negative; M 162 was negative on one occasion, and in a second test it gave only a very slight reaction.

(2) A polyvalent serum was prepared from a horse by inoculation with 20 strains of meningococci. This serum was tested with the above three strains. It was positive with M 141 and M 162, but negative with M 119.

(3) A monovalent serum was prepared from a rabbit by inoculation with M 141. This was tested with the homologous strain and also with M 162, M 135, M 164, and M 165. M. 135 and M 164 were isolated from cerebro-spinal fluid of sporadic cases of meningitis; M 165 was isolated from cerebro-spinal fluid of a case of meningitis occurring in an epidemic area. On one occasion the serum gave positive reactions with all five strains; on a second occasion the reactions with M 162 and M 164 were very slight.

(4) A monovalent serum was prepared from a rabbit by inoculation with M 162. This was tested with the homologous strain and also with M 135 and M 164. It gave positive reactions with all three.

Dopter (1911)* reported the discovery of his "para-meningococcus" in seven sporadic cases of cerebro-spinal fever. These cases were all typical, clinically, and all ended fatally.

Dopter (1912)† reported that, up to date, he had collected 12 cases of para-meningococcal cerebro-spinal fever. Clinically the cases were typical of cerebro-spinal fever, but the organisms were not agglutinated with anti-meningococcus serum, and such serum was of no therapeutic benefit. Success in treatment was, however, attained in cases where anti-para-meningococcal serum was employed.

Darre and Dumas (1914)‡ reported on cultures which they obtained from two cases of cerebro-spinal fever, one an adult and the other a child. In cultural and fermentation reactions these organisms were identical with meningococci. When tested with a meningococcus serum, both were agglutinated, one up to 1 : 100 and and the other up to 1 : 20. This they regarded, after making absorption tests, as due to group agglutination. When the serum was saturated with their organism no agglutinin was removed for an

* Bull. de la Soc. Med. des Hôp. de Paris, T. 31, p. 590.
† Bull. Soc. Med. des Hôp. de Paris. June 14th, 1912, p. 828.
‡ C. R. Soc. Biol. T. lxxvii., June 13th, 1914, p. 106.

undoubted meningococcus; but when the serum was saturated with the meningococcus it was incapable of agglutinating their new strains. Testing these two strains with Dopter's para-meningococcus serum, they found that both were agglutinated, one up to 1:500 and the other up to 1:150. When this serum was saturated with one of their strains they found it lost its property of agglutinating the para-meningococcus of Dopter. They prepared a serum from a rabbit by inoculations with the strain which only agglutinated up to 1:150 with Dopter's para-meningococcus serum. This rabbit serum gave a titre of 1: 400. It failed to agglutinate undoubted meningococci, but agglutinated Dopter's para-meningococci.

From these experiments they concluded that their two new strains were para-meningococci, but of a variety different from those previously described by Dopter, which were not agglutinated by meningococcus serum.

Dopter and Pauron (1914)* reported that they had made further investigations on para-meningococci, with a view to differentiating them from true meningococci by means of absorption tests. They found that some strains of para-meningococci were agglutinated by meningococcus serum, though the majority were not. Para-meningococcus serum very frequently agglutinated meningococci as well as para-meningococci. But the differences between these two groups of organisms became clear when absorption tests were employed. Para-meningococcus serum, saturated with meningococci, lost its agglutinin for meningococci, but retained its agglutinin for para-meningococci; the same serum, saturated with para-meningococci, lost its agglutinin for para-meningococci, but retained its agglutinin for meningococci. Meningococcus serum, saturated with meningococci, lost its agglutinin for meningococci, but retained its agglutinin for para-meningococci.

These statements were supported by a table showing tests, after absorption, with a meningococcus and a para-meningococcus serum upon selected strains of meningococci and para-meningococci. It was found that, before absorption, each of the strains was agglutinated by both sera. The number of strains was seven, viz., 4 meningococci and 3 para-meningococci. After absorption, all the tests were either completely negative or definitely positive up to 1: 600. Thus, the para-meningococcus serum, when saturated with meningococci, gave 0 with the 4 meningococci and + with the 3 para-meningococci; when saturated with para-meningococci it gave exactly the converse. And precisely similar results, *mutatis mutandis*, were obtained in the saturation experiments with the meningococcus serum.

Dopter and Pauron (1914),† in a subsequent paper, divided their para-meningococci into groups by means of saturation tests. They dealt with 7 strains of para-meningococci, designated S, W, H, B, M, L, Z.

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* C. R. Soc. Biol. T. lxxvii., June 20th, 1914, p. 157.

† C. R. Soc. Biol. T. lxxvii., June 27th, 1914, p. 231.

A horse was immunised, at first with S alone. The serum agglutinated S and 3 others, but failed with the other 3. Then the horse was inoculated with the strains which had not agglutinated. The result was a serum which agglutinated all 7, up to 1:400 or 1:600. With this serum saturation experiments were performed.

(1) After saturation with S, all agglutinin was removed for S, W, H, and B, but agglutinins remained (up to 1:400) for M, L, and Z. The results were the same when W, H, and B were used for saturation.

(2) After saturation with M, all agglutinin was removed for M and L, but agglutinins remained (up to 1:400 or 1:600) for the other 5 strains. Saturation with L gave the same result.

(3) Saturation with Z removed agglutinin for Z only, the other six being positive up to 1:400 or 1:600.

The above demarcation into three groups was confirmed by cross-agglutinations with the serum of rabbits vaccinated against each of the 7 strains. Thus: (1) the sera of rabbits vaccinated with S, W, H, and B agglutinated these 4, but failed with the remaining 3; (2) sera from M and L agglutinated M and L only; (3) the serum from Z agglutinated Z only.

They proposed to call the above three groups the a, β, and γ varieties of the para-meningococcus, and suggested that perhaps additional varieties might subsequently be found. They stated that, of the 3 varieties, a was the commonest and γ the rarest; but I was unable to find figures giving the total numbers of each which they have identified. Comparing minor differences as regards cultural growth in these 3 groups, they declared that a was apparently characterised by a growth like that of the meningococcus, as well as by its group-agglutinability by anti-meningococcus serum; β appeared to differentiate itself from the two others by producing a very viscid growth, heaped up above the surface of the medium, and it also appeared to be more resistant; γ gave a drier type of culture and its colonies appeared flatter.

Discussion of Literature on Serum Reactions.

The most important feature of the literature summarised above is that it gives evidence of substantial progress in a definite direction.

At first it was thought, despite the recognised trouble of agglutination work with other important cocci, that the agglutination test was going to be a simple matter, providing a definite and unequivocal answer to the question whether any given Gram-negative diplococcus was or was not a meningococcus.

Then a wave of scepticism supervened, because it was found that some strains of undoubted meningococci were not agglutinated by the standard serum employed. Investigation of this difficulty served at first to bring to light further complications, rather than to clear the ground, and, indeed, it induced some observers to take not merely a sceptical but a pessimistic view of the value of agglutination work. But their laboratory data,

as a frank statement of difficulties encountered, have aided progress, because they have shown (1) that, with so delicate an organism as the meningococcus, relatively slight differences in technique or condition of the culture may produce apparently wide discrepancies in results; (2) that the idiosyncrasies of individual strains of undoubted meningococci must be thoroughly worked out with monovalent sera; (3) that, until this is done, the resort to polyvalent sera, obviously actuated by the laudable desire for practical expediency, tends to mask the main scientific problem rather than to eliminate difficulties.

More or less concurrently with this output of work by observers whose conclusions practically amounted to the opinion that, in their experience, agglutination tests were unreliable, there was another trend of research, made by men who adhered, as an article of faith, to the doctrine that a really good and, preferably, polyvalent serum must be infallible, and that any meningococcus-like organism which failed to show specific agglutination with this serum must be stigmatised with some such prefix as "pseudo," "S.," or "para." In its inception, this idea, or working hypothesis, was prompted by the thoroughly sound scientific principle that a meningococcus-like organism found in the naso-pharynx, particularly if found in the naso-pharynx of a non-contact, must be put through its paces very scrupulously before it should be accepted into the order of true meningococci, capable of producing cerebro-spinal fever. But, in the course of further work on the serum reactions of these doubtful organisms, the differences of some of them from undoubted meningococci were not sharp or decisive; evidence of relationship had also to be conceded, and finally it had to be admitted that certain "para" organisms were identical in every respect with strains proved to have been the cause of cerebro-spinal fever.

These facts have cleared the ground by showing that there is a way of reconciliation between these latter results and the laboratory data of the investigators who were sceptical about the reliability of agglutination tests even with meningococci from cerebro-spinal fluid. It has become evident that serological tests have, at least provisionally, placed meningococci into a variety of groups, not, as yet, defined in respect either of number or inter-relationship; and that the criterion for a doubtful organism isolated from the naso-pharynx must be widened accordingly, so as to embrace (1) conformity with one or other of these groups, or (2) failure to conform with any of them.

Taking in detail the laboratory data furnished by individual investigations:—

The technique employed by Lingelsheim in 1906 is, in its two essentials (adoption of the macroscopic method and incubation of the dilutions overnight), identical with that which has been followed by the majority of subsequent observers. The two monovalent sera which he prepared appear to have been almost equally satisfactory in agglutinating all the strains tested with them; so there is no evidence from his work that the outbreak in Upper Silesia from which they were derived was due to more than one type of meningococcus. As neither his cerebro-spinal

strains nor his strains from the throats of contacts appear to have given any indication that sera such as he employed might not serve as a universal criterion for the diagnosis of the meningococcus, a tribute must be paid to the shrewdness of his remark that, in the case of meningococcus-like organisms obtained from non-contacts, it must be left for future research to determine whether failure to agglutinate with the particular serum employed justifies the labelling of such organisms as "pseudo."

Kutscher's work at Berlin in 1906 is particularly important from an epidemiological point of view in that he demonstrated the meningococcus in the throats of persons who had not been in contact with the disease. This work was done during the winter 1905–6, at a time when Berlin had remained completely free from the disease during a period of six months. The laboratory details of his work show that it is thoroughly reliable and that the identity of his throat organisms with true meningococci was confirmed by serological tests.

His work with Hübener in 1907 strengthens the importance of these observations, and the significance of the above results is further increased, particularly from the epidemiological aspect, by the findings, based on a much larger number of cases, which were published by Mayer and others in 1910 (p. 26).

The laboratory data published by Eberle in 1908 are of great value in showing (1) the importance of prolonged incubation of the suspensions used in agglutination tests; (2) the fact that an individual cerebro-spinal strain shows different degrees of agglutinability with different specific sera; (3), the fact that different cerebro-spinal strains show different degrees of agglutinability with the same serum. Obviously, these difficulties required further investigation before a throat coccus could be excluded from the group of meningococci because it failed to agglutinate with a particular anti-meningococcus serum.

Arkwright's technique (1909) differs from that of Lingelsheim, Kutscher, and the majority of other observers. He employed the microscopic method, at room temperature, and completed his observations at the end of two hours. Hence it is impossible to make exact comparison between his results and those obtained with the more usual technique. The difference in technique is particularly important because several investigators have shown that a period of two hours, even with incubation at 37° C., is not enough to bring out to the full the specific agglutinative capacities of the serum tested. This difficulty, however, does not obscure a very important feature of Arkwright's work; he has shown clearly that different strains of meningococci obtained in this country differed very markedly in their agglutinability with the sera with which they were tested.

His experiments on complement fixation, in 1911, also illustrate differences between different strains of meningococci.

Elser and Huntoon (1909) differ from many other observers in their method of performing agglutination tests. They incubated their suspensions for two hours at 37° C., and then kept them in the cold (9° C.) for 22 hours, the final reading being

taken 24 hours from the start. In support of this method they refer to their comparative experiments on the influence of incubator, room, and ice-box temperature. These experiments (pp. 18-19) fail, in my opinion, to justify a general statement that their method brings out agglutinability as well as incubating for 24 hours, or overnight, at 37° C. or 55° C.

Other observers have found that, when working with such a delicate organism as the meningococcus, results sometimes fail to tally on testing the same strain with the same serum upon different occasions. But Elser and Huntoon go much further; they state that the instability of the meningococcus is very pronounced and constitutes one of the great obstacles to the work. It must be left an open question whether these difficulties would have remained so great if the technique of other observers had been followed.

In their "conclusions" they make the general statement that "approximately 40 per cent. of the meningococcus strains studied were relatively inagglutinable"; and they explain elsewhere that they mean by "inagglutinable" failure to react to powerful sera in 1 : 100.

Turning to their laboratory data for recorded evidence in support of this general statement, one finds that a serum prepared from their strain M. 30 was tested with 65 strains and failed to give specific agglutination with 25 of these. This experiment is interesting and important, but insufficient, *per se*, to justify the above broad generalisation. A strain of meningococci may not be agglutinated by one serum, but that does not prove that it is insusceptible to specific agglutination by any other serum.

Seeking further evidence, one finds that experiments were made with monovalent sera prepared from other strains than M. 30, and that with these sera, again, some strains were agglutinated but not others.

Whilst recognising that this is corroborative evidence, it must be pointed out that the serological experiments which they have recorded, taken *in toto*, do not suffice to provide definite answers to the three questions: (1) Is it proved that a strain found to be agglutinated by a serum prepared against one meningococcus will necessarily be agglutinated by other sera of high titre? (2) Is it proved that a strain inagglutinable by one serum will necessarily be found inagglutinable by other sera? (3) Is there any ground for supposing that a meningococcus when tested with two different anti-meningococcic sera, each of high potency with its homologous strain, may give good agglutination with the one, but fail to agglutinate with the other? Elser and Huntoon's data, in so far as they go, would indicate that the answers to questions (1) and (2) are to be "yes," and the answer to question (3) is to be "no." Other observers, working, admittedly, with different strains, have answered questions (1) and (2) by "no" and question (3) by "yes."

Elser and Huntoon make the observation, confirmed by other bacteriologists, that a meningococcus may produce a serum which is a relatively feeble agglutinator for the homologous strain, but produces higher, and undoubtedly specific, agglutina-

tion with other strains. But whilst nearly all other observers treat this as no more than a relatively infrequent idiosyncrasy of the meningococcus, Elser and Huntoon regard it as very frequent and highly important. In fact they give the reader the impression that 40 per cent. of their strains belong to the group which are "inagglutinable" but "agglutinogenic." On searching for their recorded laboratory data in support of this view, I find (p. 21) that they are extremely scanty and by no means justify such a sweeping generalisation. In fact the number of strains shown to be agglutinogenic as well as inagglutinable is so small that this apparent discrepancy between Elser and Huntoon's results and those of other observers disappears.

Their experiments with six strains of "pseudo-meningococci," whilst showing differences between these and some of their meningococci, have not been carried far enough to justify the exclusion of the former from the class of meningococci as a whole.

Mayer (1909) maintained that an organism isolated from the naso-pharynx could not be regarded as a true meningococcus unless, in addition to conformity in cultural and fermentation tests, it was agglutinated by a good serum, such as the Höchst, up to 1:500. This criterion errs on the side of exclusiveness; no one serum, whether monovalent or polyvalent, has been found which will agglutinate without fail all strains of undoubted meningococci derived from cerebro-spinal fluid.

The work of Friese and Müller (1909), Lieberknecht (1909), and Sachs-Müke (1911) is of great importance in its bearing on the question whether persons not known to have been in contact with the disease may be carriers of the meningococcus. They all found what thay called "pseudo-meningococci" or "S." cocci"; Friese and Müller found them in the throats of soldiers during the prevalence of an epidemic regarded as influenza; Lieberknecht, in normal school children; and Sachs-Müke, in normal soldiers. From the laboratory data of their work which I have given, it is evident that they did their best to prove that these organisms were not true meningococci, but that they were compelled to admit a close kinship. They have not succeeded in proving non-identity, because the criteria on which they relied would also exclude some strains of meningococci which have been proved to be the cause of cerebro-spinal fever. I refer in particular to their assumptions (1) that one particular anti-meningococcic serum, if polyvalent and of high titre, must be infallible; (2) that a strain is not a meningococcus if its behaviour in serological reactions is not identical with one or two examples of undoubted meningococci; and (3) that there is a specific difference between true meningococci as a class and "pseudo-"-meningococci as a class in respect of their comparative agglutinability at 55° C. and 37° C. As regards this last point, it must be pointed out that Kutscher, who was the first to show the advantages of incubation at 55° C. in enhancing the agglutinability of certain strains, denies (1912)* that specific differences are

* Kolle und Wassermann. Handbuch der path. Mikroorganismen. 2nd Auflage. Bd. iv.

brought out between true and "pseudo" meningococci by comparing agglutinability at 37° C. and 55° C. He concludes his criticisms of the efforts of the above authors to distinguish their throat strains from true meningococci with a verdict of "not proven."

When Dopter, in 1909, found organisms in the naso-pharynx which differed from his strains of undoubted meningococci only in respect of certain serological reactions, he was too sound a pathologist to stigmatise these as "pseudo" (*i.e.*, not specifically pathogenic for man); he explicitly stated that he thought they might be capable of producing cerebro-spinal fever. But to distinguish them from his fully accredited meningococci he gave them the prefix of "para." In 1911 he was able to give his para-meningococci their full credentials, by producing instances where cerebro-spinal fever had been caused by them; and in 1912 he reported that the number of such cases which he had collected amounted to twelve.

The great interest and importance of this work is that it goes far beyond the stage when, though it was recognised, willingly or unwillingly, that strains of meningococci did not all agree in serological reactions, these differences were treated merely as inconvenient idiosyncrasies which should be neutralised, as far as possible, by the production of polyvalent sera. Dopter showed that serological tests brought out what appeared to be group distinctions between different strains of Weichselbaum's diplococcus, the smaller of the two groups to which he called special attention being distinguished from the larger by the somewhat irksome prefix "para."

In 1914 this "para" group received further attention at the hands of Darré and Dumas, and Dopter and Pauron; and some differences were found between individual members of it. Perhaps the sub-division of the group, by Dopter and Pauron, into α, β, and γ varieties should be regarded as merely provisional. If the authors devoted equal endeavour to the discovery of possible differences in their larger group, which I may call "ortho" as a convenient distinction from "para," they might again find distinction between individual members, tempting to another subdivision into varieties; or they might even find a strain which could not properly be called either "ortho" or "para," but demanded a third group. In short, it seems to me that it would be premature to take the division into "ortho" and "para" as completely comprehensive and final, and then try to force any and every meningococcus into one or other of these groups. The meningococci are a large family and many strains must be worked out, each on its own merits and irrespective of any preconceived idea of grouping, before it can be settled what are the distinctive features, each common to several members and confined to these members, and whether it is possible to establish a system of grouping without overlapping or cross-division. Before this is done, sub-division into α, β, and γ varieties is likely to lead to confusion.

The Investigations in the Board's Laboratory.

(1) *Meningococci from Cerebro-spinal Fluid.*

The Board's Laboratory has received for diagnosis specimens of cerebro-spinal fluid withdrawn by lumbar puncture from patients, in various parts of England and Wales, whose disease was suspected to be cerebro-spinal fever. Cultures from 16 of these cases have been utilised by Dr. Griffith and me in the present investigation. We are also indebted to Dr. Nabarro who has supplied us with 7 additional strains (5 from Great Ormond Street Hospital and 2 from private cases); to Dr. Forbes, of the London County Council, who has sent us 7 strains; and to Dr. Caiger, of the South-Western Fever Hospital, who has supplied us with 4 strains, through Dr. W. M. Scott.

The details of Dr. Scott's work on cerebro-spinal strains are given in his report (pp. 57–67).

As the cultural characters of the meningococcus are well known, Dr. Griffith and I consider that a brief description of our observations and technique will suffice. We used for plating our material Kutscher's serum-agar medium, the special features of which are that the serum is fresh ox serum and the agar is made with broth from human placentas. The day after inoculation the colonies appear as translucent, shiny, bluish grey, raised, convex discs, of circular outline and from about $\frac{1}{2}$ to $1\frac{1}{2}$ mm. in diameter. Under low magnification they appear homogeneous, or only very finely granular, and have a clear periphery. When touched with a platinum needle, they are found to be slightly viscid, not coherent and not friable. They emulsify readily. On the second day the colonies are larger (1 to $2\frac{1}{2}$ mm.), semi-opaque, with a narrow, clear periphery. The colonies are not pigmented, but the central portion of the older colonies may appear creamy or yellowish in contrast to the grey colour of the thinner peripheral zone. Microscopically, the organisms are Gram-negative diplococci, many of which are flattened along their apposed surfaces; their size is variable, some being conspicuously larger than the rest and more deeply stained; tetrads are usually found. On plain agar slants, sub-cultures from a primary colony usually give no growth, but if the tube be thickly inoculated a few colonies may develop; from later generations a fairly good growth may be obtained. At 22° C., there is no growth on gelatine; on nutrose- (or glucose-) ascitic agar there is usually no growth, but if the tube be richly inoculated there is sometimes a scanty growth, in the form of discrete colonies; on Kutscher's medium growth may fail, but a scanty growth is more frequently obtained; on egg it is the rule to obtain a growth at this temperature, usually in the form of a thin, shiny layer. The coccus rapidly dies out in unsealed tubes of Kutscher's medium or ascitic agar, but in sealed egg tubes it remains alive for several weeks.

For the fermentation tests we used Lingelsheim's solid media (ascitic agar containing 1 per cent. of the sugar and coloured with litmus). We used five sugars, viz., glucose, maltose, galactose, laevulose, and saccharose. We never obtained indication

of acid formation with any of the last three; but there was always acid formation with both glucose and maltose. Some strains produced stronger fermentation with one of these sugars than with the other.

Further observations on the fermentation tests and also the work on the serological relations of our cerebro-spinal strains are recorded in Dr. Griffith's report (pp. 41–56).

(2) *Examination of Naso-pharyngeal Swabs from Non-contacts.*

(*a*) *Patients at St. Bartholomew's Hospital.*

For this investigation the Board obtained the assistance of Mr. C. E. West, F.R.C.S., Aural Surgeon to St. Bartholomew's Hospital, who made arrangements for the examination of patients not known to have been in contact with any cases of cerebro-spinal fever.

The majority of the persons swabbed were out-patients attending the Aural Department; the rest were from other departments of the Hospital, some being wounded soldiers and the remainder civilians under treatment for one or other of a variety of medical and surgical diseases not affecting the naso-pharynx.

The persons examined were taken as general examples of hospital patients, without any selection according to their clinical condition. When pharyngitis was observed, a note to this effect was recorded.

Freshly poured plates were sent from the Board's Laboratory to the Hospital, where Mr. West, or in some cases his house surgeon, took the swabs and immediately inoculated a plate with each. Within from one to three hours after the swabbing the plates were received in the Laboratory, together with notes of each case.

Dr. F. Griffith and I then proceeded with the bacteriological investigation. The plates (Kutscher's medium) were spread at once with a bent glass rod, which was transferred to a second plate, and, when much mucus was present, from a second to a third. The time elapsing between swabbing the patient and incubating the plates did not exceed three hours. Colonies resembling meningococci macroscopically, microscopically, and in readiness of emulsification were put through the same cultural and fermentation tests as the cerebro-spinal strains.

Cultures of 502 swabs from the naso-pharynx were examined. Of these, the following are excluded in the appended tabulation of results:—8 which rapidly became overgrown; 10 which were repeats from patients previously cultured and found positive; 1 (positive) where it was found that the patient had been in contact with a case of cerebro-spinal fever; 1 (positive) where the patient gave a vague history of an illness, 3 months previously, which might have been meningitis; 2 where, on sub-culture, the cultural and fermentation reactions appeared typical at first, but yellow pigmentation subsequently developed. Of the remaining 480, 49 yielded cultures which resembled meningococci microscopically, culturally, and in fermentation tests.

Cultural Tests of Naso-Pharyngeal Swabs.

	Males.		Females.		Totals (male and female).	
Age period.	Positive.	Negative.	Positive.	Negative.	Positive.	Negative
0– 5 years...	0	13	1	8	1	21
5–10 „ ...	4	38	0	15	4	53
10–20 „ ...	8	62	3	69	11	131
20–40 „ ...	17	78	6	79	23	157
Over 40 „ ...	7	42	3	27	10	69
Totals ...	36	233	13	198	49	431
	13·4 per cent. positive.		6·2 per cent. positive.		10.2 per cent. positive.	

With reference to the interpretation of these statistics, attention must be called to the following special circumstances:—(1) The persons investigated, being hospital patients, were not representative of the normal, healthy population. (2) The swabs were taken by an aural surgeon who was expert in obtaining naso-pharyngeal swabs free from contamination by mouth organisms; so the risk of any meningococcus-like organisms present being overgrown was reduced to a minimum. (3) The medium (Kutscher's) on which the swabs were plated is especially favourable for the development of meningococcus-like organisms and for their identification. (4) In examining the plates we were more fortunately placed than bacteriologists who are required to diagnose as many cases as possible in as brief a time as possible. We never received more than 20 cases in one day, or more than about 50 in a week, and had time to make minute and repeated examination of each plate inoculated.

For the above reasons, our percentages of positives are, perhaps, above the average.

The collection of the above 480 samples commenced on March 29th, 1915, and terminated on July 22nd of the same year. The first 100 (completed April 19th) gave 20 positives; the second 100 (completed May 6th) gave 7; the third 100 (completed June 7th) gave 6; the fourth 100 (completed June 24th) gave 7; the last 80 (completed July 22nd) gave 9.

The "repeats" of previous positives were too few to justify any general conclusions. Two out of the ten were positive, one after an interval of 28 days from the first swabbing and the other after an interval of 61 days.

On comparing the positive and negative results with the clinical notes, it is not found that a conspicuously large number of the positive cases showed pharyngitis when the swab was taken.

Further work on the identification of these meningococcus-like organisms, with special reference to their serological reactions, was undertaken by Dr. F. Griffith and is recorded in his report (pp. 41–56).

(b) Investigations by Dr. Scott.

Dr. W. M. Scott, working in the Board's Laboratory independently, but on parallel lines and employing the same technique and culture media, examined naso-pharyngeal swabs from

194 non-contacts, consisting of 138 persons attending the out-patient department of the Lambeth Infirmary, and 56 children attending a rural school in Kent. His results are recorded in his report (pp. 67–73).

CONCLUSIONS.

It has been definitely established that organisms indistinguishable from meningococci by microscopic, cultural, and fermentation tests occur in the naso-pharynx of some persons who, so far as is known, have not been in contact with cases of cerebro-spinal fever.

The question whether this apparent identity can be confirmed by serological tests raises the wider problem:—what are the serological criteria to which strains of undoubted meningococci conform? This problem is far from being completely elucidated. It has, however, already been made clear that differences exist between the reactions of different strains, and that these differences appear to separate out the majority of the strains into different groups. But it is still, in my opinion, an open question to what extent and under what principles a permanent grouping can be established.

In considering the principles of classification, one must endeavour to determine distinctive group characteristics and, at the same time, to discriminate between such characteristics and minor distinctions which might, perhaps, offer a basis for sub-grouping. Taking the experimental work in the order of laboratory procedure, there are, at once, three important characteristics which require consideration. The first step is to immunise an animal with a particular culture; the second to see what strains are agglutinated by the serum prepared; and the third, when necessary, to ascertain by absorption tests if the agglutination is specific. Correspondingly, the three characteristics to be considered as criteria are:—(1) agglutinogenic capacity; (2) agglutinability; (3) absorptive capacity. If each individual strain of meningococci behaved consistently in respect of these three criteria, there would be a substantial basis for the grouping of different strains. But if individual strains differ in the above respect, grouping under these three criteria would lead to cross-division. Such cross-division could only be avoided by making one of these criteria absolute, and relegating the other two to the minor function of criteria for sub-grouping. In my opinion, enough work has not yet been done to justify the establishment of criteria for the demarcation into hard-and-fast groups; and, in view of this consideration, I think it would be premature to adopt a particular standard and then attempt to dispose of discrepancies from it by elastic expansion into sub-groups.

It is likely to be a long time before the question of classification is finally settled. In the meantime, comparative serological tests are available between individual cerebro-spinal strains and strains of naso-pharyngeal origin. It has been found that some of the latter, derived from non-contacts, coincide with certain cerebro-spinal strains, and that other non-contact strains, though not coinciding precisely, show serological relationship to cerebro-spinal strains.

How far do the above considerations provide an answer to the question: is a naso-pharyngeal strain, found identical with true meningococci in cultural and fermentation tests, to be regarded, *ipso facto*, as capable of producing cerebro-spinal fever in a suitable soil? It is impossible to reply by a categorical "Yes" or "No," because the evidence is incomplete. The balance of available evidence is on the side of "Yes." Is future work likely to reverse that balance? It might, if it can be shown that serum reactions or animal experiments place the great majority of non-contact strains into a distinct class. But this evidence is not yet forthcoming. If it is provided in the future, it will be necessary for me to reconsider my present opinion, which is that all naso-pharyngeal strains, as defined above, should be regarded as possibly capable of producing cerebro-spinal fever.

III.—Identification of the Meningococcus in the Naso-Pharynx with special reference to Serological Reactions; by Fred. Griffith, M.B.

In view of the apparent identity, so far as morphological and cultural characters are concerned, of meningococci from cases of cerebro-spinal meningitis with certain gram-negative cocci found in the naso-pharynx of non-contacts, it has been necessary to resort to serological tests to obtain further information on the question of their inter-relationship.

Monovalent agglutinating sera have been prepared from several varieties of each class of cocci and cross agglutination experiments have been made. The tests have been applied to cerebro-spinal strains and to naso-pharyngeal strains isolated during the recent epidemic. The strains used are those mentioned in Dr. Eastwood's Report (pp. 37–39), which have been jointly investigated by us as regards cultural characters and fermentative capacities. I have submitted to agglutination tests the 34 cerebro-spinal strains and 30 of the naso-pharyngeal strains from patients at St. Bartholomew's Hospital not known to have been in contact with cases of cerebro-spinal meningitis.

Before proceeding to the work on agglutination, I record additional observations on the cultural and fermentative capacities of the strains investigated, with special reference to differential features on various media. For his assistance in the arrangement of the subject matter of this report, I am greatly indebted to Dr. Eastwood.

Further Observations on Cultural Characters and Fermentation Tests.

In examining the primary cultures on placental serum agar plates, slight differences were noted between the meningococcus colonies from the cerebro-spinal fluid and the meningococcus-like organisms from the naso-pharynx. These differences, consisting mainly of slight variations in opacity, were eliminated

when colonies of either class were plated in pure culture on fresh medium. Changes in shape and structure of single colonies were common to both classes of cocci as they increased in age. In fact, all slight variations in colour, consistency, ease or difficulty of growth, fermentative activity, or viability of the cerebro-spinal strains were also met with among the naso-pharyngeal strains, but none was found to be a feature distinguishing the one class from the other.

The fermentation tests of various sugars are next in order of importance to the appearances of the primary colonies as a means of identifying the meningococcus. Maltose and glucose only showed evidence of acid fermentation. Meningococci, recently isolated from cerebro-spinal fluid, rarely produced equal amounts of acidity from glucose and maltose contained in Lingelsheim's solid sugar media. They could, with a few exceptions, be placed in one or other of two groups, according as they fermented glucose or maltose more strongly, and, as will be seen in Table I., the two groups were correlated with the serological grouping. In the case of the naso-pharyngeal strains, on the other hand, both sugars were more often equally fermented (Table II.). In fact, this feature was so noticeable that, in the early part of the work, it was considered as a possible means of distinguishing the so-called pseudo-meningococcus from the true meningococcus. But further observations showed that some strains of meningococci, recently obtained from cerebro-spinal fluid, fermented maltose and glucose equally. The acidity with either of the two sugars was sometimes extremely slight in degree and evanescent. The above observations, recorded in Tables I. and II., refer to tests on strains recently isolated. On repeating the tests after prolonged sub-cultivation, the differences at first noted were in many cases found to have disappeared, and in one case even to be reversed.

On egg meningococci grow readily, producing a smooth, shiny layer slightly pink at the bottom of the tube, the same tint appearing in the growth when heaped up. Cultures remain alive in sealed tubes of this medium for many weeks and have been subcultivated after seven months in the incubator at 22° C.

Glucose agar was found to be a useful medium for producing considerable quantities of culture; it has the advantage of giving a firm surface which facilitates the removal of the growth with a platinum spatula. It was difficult to induce some strains to grow on this medium, when first transferred from one containing serum; in this respect some of the naso-pharyngeal strains were found to be the most obstinate. With such strains the early growths produced on the glucose agar were very sticky. In preparing this medium, in order to avoid unfavourable changes in reaction, it is advisable to add the sugar, sterilised in distilled water, after the final sterilisation of the nutrient agar.

Technique of Agglutination Tests.

The sera were prepared by inoculating intravenously adult rabbits with increasing doses of living culture grown on glucose agar. The dose ranged from $\frac{1}{8}$ tube of culture to $1\frac{1}{2}$ tubes, which was found to be as much as could be given without killing the animal. The inoculations were usually made at intervals

of 8–10 days, but no regular routine was followed in this respect. The progress of immunisation was followed by making frequent tests of small quantities of blood serum withdrawn from an ear-vein. Inoculations were repeated until a workable serum was produced, the time necessary to this end varying, with different rabbits, from 4 weeks to 14 weeks.

The culture suspensions were standardised in the following way. The moist growth on several glucose agar tubes of 24 hours' incubation was removed and weighed on a chemical balance. After emulsifying in ·5 per cent. carbolic acid in normal salt solution, and heating to 65° C. for an hour, the suspensions were diluted to a uniform strength of 4 mg. per cubic centimetre, and were stored in rubber-capped tubes in a cool dark place.

The agglutination tests were made in tubes measuring 3 in. by ½ in. To each ·5 c.c. of serum dilution, ·5 c.c. of culture suspension was added and the tubes were placed in the incubator at a temperature of 55° C. for 24 hours, when the first readings were taken. They were then removed to the ice-chest and the final results were noted the following morning.

In order to present the results in a convenient manner, since it was impossible to give all the tables in full, it was necessary to select an end point. I have chosen as my end point the highest dilution in which the cocci had clumped and sedimented, leaving the supernatant fluid clear, or with the faintest suspicion of turbidity. This is represented in the tables by a figure giving the numerical value of the dilution. When the turbidity, though slight, was distinct and agglutination was well marked, the result is represented by the symbols $\pm$ or $\mp$, according to the degree of turbidity, $\pm$ meaning agglutination well marked but incomplete in 1 in 50, $\mp$ meaning agglutination slight but definite. The negative sign indicates that the reaction was completely negative in 1 in 50, the highest concentration of serum considered, or showed no more than a trace of agglutination.

In order to compare agglutination with fermentative activity of individual strains, I have inserted in each of the tables a column showing the relative activity of each strain upon maltose and glucose.

In making orientation tests with a view to determining from which strains to prepare serum, I first selected two strains of cerebro-spinal origin, M 8 and M 23, the former because it fermented maltose more than glucose and the latter because its action on these two sugars was the reverse. On testing several strains of meningococci with these two sera I found obvious differences in agglutinability which appeared to coincide with differences in fermentative capacity. The subsequent selection of strains for the preparation of sera was determined by the differences in agglutinability already observed. At this stage it was found that the majority of the strains tested were agglutinated by one or other of the five sera, M 8, M 23, M 9, M 24, and M 28. With a few of the strains, however, none of the sera gave good agglutination, and two of these last strains, M 17 and M 32A, were selected for the production of immune sera. On completing my results I re-arranged my strains in the order which exhibited most clearly their differences in agglutinability.

TABLE I.

Cross-agglutination tests with 34 strains of meningococci and monovalent sera prepared with 7 cerebro-spinal fluid strains and 3 naso-pharyngeal strains of Gram-negative cocci:—

Strain.	Fermentation of glucose and maltose.	M. 8 Serum.	M. 23 Serum.	M. 9 Serum.	M. 24 Serum.	M. 28 Serum.	M. 17 Serum.	M.32A. Serum.	N.P. 11 Serum.	N.P. 10 Serum.	N.P. 26 Serum.	Normal Rabbit Serum.
M. 1 ...	M. > G.	1,000	−	1,000	−	−	100	±	400	±	±	−
M. 2 ...	M. > G.	1,000	±	1,000	∓	∓	200	−	500	50	±	−
M. 3 ...	M. > G.	800	50	1,000	±	−	200	−	500	±	±	−
M. 4 ...	M. > G.	800	50	800	∓	±	200	−	400	50	±	−
M. 5 ...	M. > G.	800	±	800	−	∓	100	−	400	±	−	−
M. 6 ...	M. > G.	600	±	800	−	−	100	∓	400	±	∓	−
M. 7 ...	M. > G.	500	50	500	50	−	100	−	300	−	∓	−
M. 8 ...	M. > G.	400	±	400	50	±	100	±	200	±	±	−
M. 9 ...	M. > G.	400	∓	400	±	±	100	−	400	−	±	−
M. 10 ...	M. > G.	200	−	300	−	−	200	−	400	−	−	−
M. 11 ...	M. > G.	200	±	400	100	±	100	±	600	±	−	−
M. 12 ...	Equal	100	−	400	±	−	800	−	400	−	−	−
M. 13 ...	M. > G.	100	50	400	±	∓	400	∓	400	−	±	−
M. 14 ...	M. > G.	100	∓	400	50	−	100	−	400	±	−	−
M. 15 ...	M. > G.	100	−	400	50	−	100	∓	400	−	±	−
M. 16 ...	M. > G.	100	−	100	50	100	−	50	50	±	∓	−
M. 17 ...	Equal	50	∓	100	∓	∓	400	∓	400	−	−	−
M. 18 ...	Equal	−	1,000	−	800	500	−	50	100	400	50	−
M. 19 ...	G. > M.	∓	1,000	±	800	400	200	400	∓	400	±	−
M. 20 ...	G. > M.	∓	800	−	800	300	−	100	50	800	100	−
M. 21 ...	Equal	100	800	∓	1,000	500	−	300	±	500	100	−
M. 22 ...	G. > M.	∓	600	−	400	500	−	400	300	200	200	−
M. 23 ...	G. > M.	−	500	−	100	400	−	400	±	200	∓	−
M. 24 ...	G. > M.	±	500	−	300	500	−	200	±	200	±	−
M. 25 ...	G. > M.	±	400	±	800	200	−	±	±	200	±	−
M. 26 ...	G. > M.	−	400	−	800	300	−	400	100	100	−	−
M. 27 ...	G. > M.	−	400	−	800	500	100	50	±	400	−	−
M. 28 ...	G. > M.	−	400	−	100	500	−	−	±	200	∓	−
M. 29 ...	G. > M.	−	400	∓	800	500	−	50	±	200	50	−
M. 30 ...	G. > M.	−	400	−	800	300	−	100	100	300	±	−
M. 31 ...	G. > M.	−	200	−	100	200	100	50	100	50	±	−
M. 32 ...	Equal	−	±	−	50	∓	±	800	±	−	±	−
M. 32A ...	Equal	−	±	−	50	∓	−	800	±	±	50	−
M. 33 ...	G. > M.	±	∓	−	100	50	−	50	100	±	100	−
*M. 34 ...	G. > M.	+	+	+	+	+	+	+	+	+	+	+

The symbols ±, ∓, −, refer to reactions at 1:50.
± = Well marked but incomplete agglutination.
∓ = Slight but definite agglutination.
− = No agglutination.

* This strain possessed the property of auto-agglutination.

TABLE II.

Cross-agglutination tests with 30 strains of naso-pharyngeal Gram-negative cocci and monovalent sera prepared with 6 cerebro-spinal fluid strains and 3 naso-pharyngeal strains:—

Strain.	Fermentation of glucose & maltose.	M. 8 Serum.	M. 23 Serum.	M. 9 Serum	M. 24 Serum.	M. 17 Serum.	M. 32A Serum.	N.P. 11 Serum.	N.P. 10 Serum.	N.P. 26 Serum.	Normal Rabbit Serum.
N.P. 1	M. > G.	800	—	1,000	∓	100	±	400	—	±	—
N.P. 2	Equal	200	±	300	200	100	50	400	100	200	—
N.P. 2A	M. > G.	100	—	50	50	50	±	300	±	50	—
N.P. 3	Equal	50	∓	100	±	∓	50	200	±	100	—
N.P. 4	M. > G.	50	—	50	300	±	400	100	—	100	—
N.P. 5	Equal	±	±	±	50	100	200	400	—	100	—
N.P. 6	G. > M.	—	800	∓	300	—	50	100	200	100	—
N.P. 7	G. > M.	—	400	—	100	—	100	50	100	100	—
N.P. 8	G. > M.	—	400	±	100	—	100	300	200	±	—
N.P. 9	Equal	±	400	±	300	±	400	300	200	200	—
N.P. 10	G. > M.	—	500	—	800	—	±	50	500	50	—
N.P. 11	M. > G.	∓	400	∓	300	50	50	300	100	±	—
N.P. 12	Equal	±	50	∓	100	—	100	100	∓	100	—
N.P. 13	M. > G.	∓	50	∓	50	∓	200	400	—	±	—
N.P. 14	G. > M.	50	∓	±	200	±	100	400	100	100	—
N.P. 15	Equal	±	∓	±	100	±	100	100	—	±	—
N.P. 16	Equal	±	±	±	200	50	200	800	200	400	—
N.P. 17	M. > G.	±	—	...	100	—	200	400	100	400	—
N.P. 17A	Equal	±	—	±	±	—	200	400	±	300	—
N.P. 18	Equal	±	—	±	50	—	200	400	—	300	—
N.P. 19	Equal	±	±	±	50	±	50	300	±	100	—
N.P. 20	Equal	—	—	—	±	—	50	400	—	50	—
N.P. 21	Equal	±	—	±	±	∓	±	400	±	100	—
N.P. 22	M. > G.	∓	∓	±	±	—	100	400	±	100	—
N.P. 23	Equal	±	—	∓	±	—	50	400	±	100	—
N.P. 24	Equal	±	—	±	±	—	±	400	—	±	—
N.P. 25	M. > G.	±	—	±	±	±	±	400	—	100	—
N.P. 26	Equal	∓	∓	±	±	—	200	200	±	400	—
N.P. 27	M. > G.	—	—	±	∓	—	±	400	—	100	—
N.P. 28	Equal	—	—	∓	100	—	—	±	—	—	—
N.P. 29	Equal	—	—	...	±	—	±	50	...	±	—
N.P. 30	...	—	—	—	—	—	—	—	—	—	—

The symbols ±, ∓, —, have the same significance as in Table I.
N.P. = Non-contact naso-pharyngeal strain.

Analysis of Table I.

Table I. gives the results of agglutination tests performed upon 34 strains of meningococci, with sera prepared from 7 of the same, and from 3 meningococcus-like organisms of naso-pharyngeal origin. The test with the first serum, M. 8, shows that this divides the meningococci into agglutinable and inagglutinable strains. That the inagglutinability is only relative to the particular serum employed will be seen on examination of the next column, where the series is tested with serum prepared from one of the strains, M. 23, not agglutinated by M. 8 serum. So far the results appear to justify the division of the meningococci into two main groups—Group I. from M. 1 to M. 17, and group II. from M. 18 to M. 31. The remaining four strains, two of which, M. 32 and M. 32A, came from the same patient after an interval of 15 days, can be included in neither of the two groups, since in three, agglutination is insufficiently marked, and in the fourth, M. 34, is not specific, since agglutination took place in normal salt solution, and with normal rabbit serum.

On examination of the individual strains in group I., one finds marked differences in the degree to which they are agglutinated by M. 8 serum. Several show no more agglutination than M. 21, which has been included in group II. In group II. likewise the various strains are unequally agglutinated by M. 23 serum. With M. 17, the least agglutinable of group I., a serum was prepared and tested on the whole series. It was found to agglutinate, with a single exception, all the individuals in group I., and, in addition, three in group II. This shows that, in respect of its agglutinogenic capacity, M. 17 belongs to group I.

In addition to the above three sera, I have prepared also sera from M. 9, a member of the first group, and from M. 24 and M. 28, members of the second group. In column five, M. 9 serum is markedly specific in its action upon strains in group I. M. 24 and M. 28 sera agglutinate mainly strains in group II.* These three sera, therefore, corroborate the above division of the strains into groups I. and II.

The two strains of M. 32 and the strain M. 33 may now be considered. From the agglutination tests with the sera prepared with M. 8, M. 23, M. 9 and M. 17, there is no evidence that they are related to one group more than the other, and, indeed, no serological evidence that they are meningococci. But the serum M. 24 was found to agglutinate them slightly. A serum was then prepared from M. 32, which shows that this strain has agglutinogenic capacities establishing its relationship to meningococci of group II. In preparing a serum from M. 33 (not included in the table), more than usual difficulty was experienced, and up to the present no higher titre than 1 in 100 for the homologous strain has been reached. With this serum several strains in group II. only were agglutinated, in dilutions of 1 in 50 and 1 in 100.

* M 28 was a more active serum than would appear but owing to an accident to a centrifuge tube only sufficient serum was preserved to make the test on the whole series in dilutions from 1 in 50 to 1 in 500.

The auto-agglutinating strain, M. 34, was heated to 80° C. for an hour. This treatment apparently destroyed the auto-agglutinating property and a permanent suspension in salt solution could be made, which showed no trace of agglutination in normal rabbit serum in a dilution of 1-10. This suspension of M. 34, tested subsequently with immune sera, gave an agglutination titre of 1 in 1,000 with M. 23 serum, 1 in 800 with M. 32A serum, and only a slight agglutination in 1 in 200 with M. 8, results which indicate that the strain probably belongs to group II.

The agglutination tests with the three sera N.P. 11, N.P. 10, N.P. 26, can best be considered in conjunction with the tests given in Table II. on the naso-pharyngeal strains.

The salient facts brought out in Table I. are (1) that a series of meningococci tested upon a monovalent meningococcus agglutinating serum can be arranged to show a progressive diminution in agglutinability, ending in a number of completely inagglutinable strains; (2) a second monovalent serum will give a similar result, but in inverse order, the inagglutinable becoming the agglutinable.

But when a larger number of sera is employed, this parallelism between (1) and (2) is found not to be absolute, since certain strains which were inagglutinable in (1), but agglutinable in (2), do not always correspond in regard to agglutinability or inagglutinability, respectively, when tested with other sera prepared with members of groups I. and II.

Analysis of Table II.

The 30 naso-pharyngeal strains have been tested with 9 of the sera, the agglutinating properties of which have been studied in relation to meningococci of cerebro-spinal origin.

In consequence of the difficulty in obtaining good growths of many of the naso-pharyngeal strains upon glucose agar, a sufficient quantity of culture suspension was not made at one time for the whole series of tests, as was the case with the majority of the cerebro-spinal fluid strains. The different suspensions of the same strain have not been equally agglutinable, and in repeated tests the agglutination results, though in general conformity, have not been always identical.

Applying the same method of analysis as in the consideration of Table I., I find that the two sera, M. 8 and M. 23, each divide the series into an agglutinable and an inagglutinable class. Whereas in the case of the cerebro-spinal meningococci, the strains relatively inagglutinable to both sera were few in number, in this series they comprise the majority. As with the cerebro-spinal meningococci, the agglutinable naso-pharyngeal strains are divided into two groups by the sera M. 8 and M. 23. M. 9 serum also agglutinates only the same four strains as M. 8 serum, thus confirming the almost complete identity of agglutinogenic function already exhibited by the strains M. 8 and M. 9 in relation to the cerebro-spinal fluid strains. Again, M. 24 serum agglutinates the same strains as M. 23 serum, but the agglutinogenic capacity of M. 24 has a wider range, since the serum agglutinates in addition a number of other strains. Still greater agglutinating capacity towards the naso-pharyngeal strains is shown by M. 32A

serum. M. 32A is a meningococcus strain, which was agglutinated, to any considerable extent, by the homologous serum alone, though the serum prepared from it agglutinated several cerebro-spinal strains of Group II. Thus agglutinogenic capacity demonstrates its relationship alike to the cerebro-spinal meningococci and to the naso-pharyngeal cocci.

N.P. 11 produces a serum which has marked agglutinating properties for almost all the naso-pharyngeal strains, as well as for cerebro-spinal strains in both of the groups. With this strain, however, agglutinability and agglutinogenic capacity are not in correspondence. N.P. 11 is agglutinated by the sera of M. 23 and M. 24, members of Group II., but the serum produced by N.P. 11 agglutinates mainly members of Group I., giving only incomplete reactions in 1 : 50 with M. 23 and M. 24.

N.P. 10 which was agglutinated by M. 23 serum, produces a serum, which agglutinates with a few additions the same naso-pharyngeal strains as M. 23 serum, and reference to Table I. shows that N.P. 10 serum acts mainly upon the group of meningococci to which M. 23 belongs.

From the above considerations it is clear that there is a definite relationship between the cerebro-spinal meningococci and many of the naso-pharyngeal cocci. Some, however, of the latter strains were agglutinated only to a very slight extent by the six immune sera produced by meningococci of cerebro-spinal origin. The question arises whether it is possible by serological tests to justify a classification of these cocci as meningococci. It has already been pointed out, in analysing Table I., that two strains from cases of meningitis, M. 32 and M. 33, agglutinated only to a minor degree with five meningococcus immune sera, but their identity with meningococci has been confirmed by demonstration of their specific agglutinogenic capacity. Experiments on similar lines have been begun with the naso-pharyngeal strains which are apparently inagglutinable when tested by some of the above meningococcus immune sera. Some progress in this direction has already been attained. With one of these strains, N.P. 26, an agglutinating serum was prepared. This serum agglutinated to some extent the majority of the naso-pharyngeal strains, and (Table I.) a number of the meningococci in Group II.

The two strains which differed in certain cultural features from meningococci, N.P. 29 and N.P. 30, have been included as controls. N.P. 29 produced slight yellow pigmentation on glucose ascitic agar, but fermented only maltose and glucose. N.P. 30 was markedly pigmented and fermented in addition laevulose.

The points of importance in the analysis of this table of agglutination tests are (1) that the majority of the naso-pharyngeal strains, fermenting only glucose and maltose, show some degree of correspondence with meningococci of cerebro-spinal origin as regards agglutinability; (2) a certain number can definitely be pronounced as identical with standard strains of meningococci; (3) when agglutinogenic capacity is included as proof of relationship, further evidence is provided of correspondence between cerebro-spinal meningococci and naso-pharyngeal strains of non-contacts.

Agglutinin Absorption Experiments.

The following experiments have been made with the object of comparing absorptive capacity with agglutinability.

Experiment 1.

M. 8 serum absorbed with cerebro-spinal and naso-pharyngeal strains.

Each absorbing strain was suspended in 1 c.c. of 1 in 10 dilution of serum. In Table III. A the amount of culture added was the whole of the living 24-hour growth from one glucose ascitic agar culture, in Table III. B the growth from two tubes. The tubes together with the control serum dilution were incubated at 55° C. for 2 hours and placed over night in the ice-chest. After centrifuging, the agglutination tests were made upon the homologous strain (the culture suspension of the homologous strain in A was a little less agglutinable than that used in B). Almost complete absorption occurred with four cerebro-spinal strains, including the homologous, and with one naso-pharyngeal strain; of the remaining some showed slight absorption, others none.

TABLE III.*

A

Absorbing strain.	Dilutions of absorbed serum tested upon homologous strain.					Titre of absorbing strain for M. 8 serum before absorption.
	40	80	160	320	640	
(Control serum)	+	+	+	+	trace	...
M. 8 ...	trace	–	–	–	–	400
M. 9 ...	±	–	–	–	–	400
M. 3 ...	trace	–	–	–	–	800
M. 4 ...	trace	–	–	–	–	800
M. 16 ...	+	+	±	–	–	100
M. 17 ...	+	+	+	±	trace	50
M. 32 ...	+	+	+	+	trace	–
M. 23 ...	+	+	+	+	trace	–
M. 32A ...	+	+	+	±	trace	–
M. 33 ...	+	+	+	+	trace	±
M. 24 ...	+	+	+	+	trace	±
N.P. 1 ...	trace	–	–	–	–	800
N.P. 14 ...	+	+	±	trace	–	50
N.P. 4 ...	+	+	±	±	–	50
N.P. 15 ...	+	+	+	+	trace	±
N.P. 13 ...	+	+	+	+	trace	∓
N.P. 9 ...	+	+	+	+	trace	±
N.P. 27 ...	+	+	+	+	trace	–
N.P. 17 ...	+	+	+	+	trace	±

* In this and the following tables—
+ Complete agglutination.
± Marked, but incomplete agglutination.
∓ Slight, but definite agglutination.

B

Absorbing strain.	Dilutions of absorbed serum tested upon homologous strain.					Titre of absorbing strain for M. 8. serum before absorption.
	40	80	160	320	640	
(Control serum)	+	+	+	+	±	...
N.P. 2 ...	+	+	+	±	–	200
N.P. 2A ...	+	+	±	±	–	100
N.P. 17 ...	+	+	+	+	±	±
N.P. 18 ...	+	+	+	+	±	±
N.P. 20 ...	+	+	+	±	±	–
N.P. 21 ...	+	+	+	±	∓	±
N.P. 22 ...	+	+	+	±	∓	∓
N.P. 16 ...	+	+	+	+	±	±
N.P. 25 ...	+	+	+	+	±	±
N.P. 11 ...	+	+	+	+	±	∓

Experiment 2.

M. 23 serum absorbed with cerebro-spinal and naso-pharyngeal strains.

In Table IV. A the method of absorption was similar to that in Experiment I. Table IV. B shows the effect of absorption on two successive occasions, each time with the growth from a single glucose ascitic agar tube.

The homologous strain alone absorbed the specific agglutinin completely with a single treatment. Different degrees of absorption were shown by several naso-pharyngeal strains, complete with N.P. 8, after the second treatment.

TABLE IV.*

A

Absorbing strain.	Dilutions of absorbed serum tested upon homologous strain.					Titre of absorbing strain for M. 23 serum before absorption.
	40	80	160	320	640	
(Control serum)	+	+	+	+	±	...
M. 23 ...	–	–	–	–	–	500
M. 24 ...	+	±	trace	trace	–	500
M. 22 ...	+	+	±	±	trace	600
M. 20 ...	+	+	±	±	trace	800
M. 32A ...	+	+	+	±	±	±
M. 33 ...	+	+	+	+	±	∓
M. 32 ...	+	+	+	+	±	±
M. 8 ...	+	+	+	+	±	±
M. 9 ...	+	+	+	+	±	∓
M. 16 ...	+	+	+	+	±	–
N.P. 6 ...	+	+	±	±	trace	800
N.P. 8 ...	+	±	±	∓	–	400
N.P. 9 ...	+	+	±	±	±	400
N.P. 10 ...	+	+	±	±	–	500
N.P. 11 ...	+	+	+	±	±	400
N.P. 12 ...	+	+	+	±	±	50
N.P. 13 ...	+	+	+	+	±	50
N.P. 14 ...	+	+	+	+	±	±
N.P. 3 ...	+	+	+	+	±	∓

* In this and the following tables N.P. = non-contact naso-pharyngeal strain.

B

Absorbing strain.	Dilutions of absorbed serum tested upon homologous strain.					Titre of absorbing strain for M. 23 serum before absorption.
	60	120	240	480	960	
(Control serum)	+	+	+	+	±	...
N.P. 8 ...	–	–	–	–	–	400
N.P. 10 ...	±	±	trace	–	–	500
N.P. 6 ...	+	∓	trace	–	–	800
N.P. 7 ...	+	+	±	trace	–	400
N.P. 24 ...	+	+	±	∓	trace	–
N.P. 9 ...	±	±	±	trace	trace	400
N.P. 4 ...	+	+	+	±	∓	–
N.P. 17 ...	+	+	+	+	±	–
N.P. 18 ...	+	+	+	+	±	–
N.P. 29 ...	+	+	+	+	±	–
N.P. 26 ...	+	+	+	+	±	∓
N.P. 16 ...	+	+	+	+	±	∓
N.P. 12 ...	+	+	+	+	±	50

Experiment 3.

In absorption experiments 1 and 2, where sera M. 8 and M. 23 have been treated on a single occasion with culture N.P. 11, the agglutinating capacity of these sera towards the homologous strains has not been appreciably diminished. In the following experiment sera M. 8 and M. 23 were treated on four successive occasions with culture N.P. 11. The concentration of serum was 1 in 20, and in each case 4 c.c. were exhausted with the growth from 7 glucose agar tubes divided into four portions. After each addition of culture the tubes were incubated for 2 hours at 55° C. and centrifuged; tubes containing serum dilution alone were incubated and centrifuged at the same time. The sera were treated in identical manner with the other cultures included in the tables.

Tables V. and VI. show that N.P. 11 absorbs agglutinin from both sera, the absorption of M. 23 serum being the more marked. N.P. 29 and 30, both pigmented strains, the latter a laevulose fermenter, were used as controls; they have not absorbed any of the specific agglutinin. N.P. 10 has already been shown (Table IV. A) capable of absorbing M. 23 agglutinin.

TABLE V.

M. 8 serum.

Absorbing strain.	Dilutions of absorbed serum tested on homologous strain.				
	80	160	320	640	1280
(Serum control)	+	+	+	∓	–
N.P. 29	+	+	+	∓	–
N.P. 30	+	+	+	∓	–
N.P. 11	+	±	∓	–	–

TABLE VI.

M. 23 serum.

Absorbing strain.	Dilutions of absorbed serum tested on homologous strain.				
	80	160	320	640	1280
(Serum control)	+	+	+	∓	trace
N.P. 30	+	+	+	∓	trace
N.P. 10	±	±	trace	–	–
N.P. 11	±	∓	trace	–	–

Experiment 4.

M. 8 serum absorbed on three successive occasions with N.P. 11 culture (Table VII.): 10 c.c. of 1 : 10 dilution of serum treated with the growth from 10 glucose agar tubes. The serum after absorption was tested as to its agglutinating capacity upon the homologous strain and upon several cerebro-spinal and naso-pharyngeal strains. The results show that N.P. 11 culture has absorbed from M. 8 serum the agglutinin that had, before the absorption, acted upon eight strains of meningococci.

TABLE VII.

Strain.	50	100	200	300	400	500	600	Titre of tested strain for the unabsorbed serum.
M. 8	+	+	+	±	±	±	±	400
M. 3	+	+	+	+	±	±	±	800
M. 9	–	–	–	–	–	–	–	400
M. 11	+	∓	–	–	–	–	–	200
M. 15	trace	–	–	–	–	–	–	100
M. 16	trace	–	–	–	–	–	–	100
M. 14	∓	–	–	–	–	–	–	100
M. 21	–	–	–	–	–	–	–	100
M. 13	–	–	–	–	–	–	–	100
M. 12	–	–	–	–	–	–	–	100
M. 17	–	–	–	–	–	–	–	50
N.P. 1	+	+	+	+	±	...	...	800
N.P. 2A ...	trace	–	–	–	–	...	...	100
N.P. 2 ...	∓	∓	∓	trace	trace	...	...	200
N.P. 11 ...	–	...	...	...	...	...	...	50

Experiment 5.

M. 23 serum absorbed on three successive occasions with N.P. 11 culture and tested upon the homologous strain, in addition to several cerebro-spinal and naso-pharyngeal strains: 15 c.c. of 1 : 10 dilution of serum treated with the growth from 12 glucose agar tubes. The results show (Table VII.) that the agglutinins for several of the cerebro-spinal meningococcal strains are reduced, and in one case, M. 22, completely absorbed.

TABLE VIII.

Strain.	50	100	200	300	400	Titre of tested strain for unabsorbed serum.
M. 23	+	+	±	∓	trace	500
M. 18	+	+	±	∓	–	1000
M. 22	–	–	–	–	–	600
M. 26	±	∓	–	–	–	400
M. 28	+	±	∓	trace	...	400
M. 19	+	±	±	trace	trace	1000
M. 20	+	±	trace	trace	...	800
M. 21	+	±	trace	...	...	800
M. 24	+	+	±	±	–	500
M. 29	+	±	trace	trace	...	400
M. 25	±	±	–	–	–	400
M. 30	±	±	–	–	–	400
M. 27	+	±	trace	trace	–	400
N.P. 11 ...	–	–	–	–	–	400
N.P. 6	±	±	∓	trace	–	800
N.P. 10 ...	+	±	∓	trace	–	500
N.P. 9	∓	–	–	–	–	400
N.P. 8	±	∓	trace	–	–	400
N.P. 7	+	±	∓	trace	–	400

Experiment 6.

Absorption experiment with M. 9 serum (Table IX.). In each case 1·5 c.c. of 1 : 10 dilution of serum was treated with the growth from a single glucose ascitic agar tube.

M. 8 and M. 9 have absorbed almost completely the specific agglutinin from M. 9 serum. In Experiment 1 M. 9 was shown to absorb the specific agglutinin from M. 8 serum.

TABLE IX.

Absorbing strain.	Dilutions of absorbed serum tested upon homologous strain.				
	80	160	320	640	1280
(Control serum)	+	+	+	±	trace
M. 8	trace	–	–	–	–
M. 9	trace	–	–	–	–
M. 16	+	+	+	trace	–
M. 11	+	+	+	trace	–
M. 13	+	+	+	trace	–
M. 14	+	+	+	trace	–
M. 17	+	+	+	trace	–
M. 15	+	+	±	∓	–
M. 12	+	+	±	∓	–
N.P. 11	+	+	+	∓	–

Analysis of Absorption Experiments.

Absorption experiments 1 and 2 demonstrate that strains which, on the score of agglutinogenic capacities or agglutinability might be regarded as belonging to the same group do not necessarily coincide in absorptive capacities. In Experiment 1 there is a correspondence between agglutinability and absorptive capacity, but not in Experiment 2.

Experiment 3 shows that a naso-pharyngeal strain has absorbed specific agglutinin from sera of both groups of cerebro-spinal meningococci and that absorption was more marked with that serum which agglutinated the absorbing strain.

Experiment 4 shows that a naso-pharyngeal strain has removed from a cerebro-spinal meningococcus serum a certain amount of the agglutinin for the strain homologous to that serum, but has removed all the agglutinin for a second strain, which (Experiments 1 and 6) has been shown to be identical with the homologous strain.

Experiment 5 shows that a naso-pharyngeal strain has removed from a meningococcus serum, to an unequal extent, the agglutinin for other strains belonging to the same group.

Experiment 6 demonstrates equal absorptive capacity in M. 8 and M. 9, members of the same group.

Summary of Results.

Simple agglutination tests divided into two main groups a series of 34 meningococci obtained from the cerebro-spinal fluid of cases of meningitis during the recent epidemic.

Certain of these strains of meningococci, which were either not agglutinated or only slightly by any of the sera employed, could be placed in one or other of the groups by the demonstration of their agglutinogenic capacity.

Certain individual strains in each of the groups were agglutinated to a less degree than the homologous strain, and certain strains were agglutinated by sera of both groups.

For further evidence as to specific relationship resort was made to agglutinin absorption experiments.

While the question, as to whether meningococci can be divided into independent groups by means of agglutinin absorption tests must, at this stage of the investigation, remain open, the experiments detailed above indicate that variations in absorptive capacity between individual strains of meningococci are analogous to, though not in actual correspondence with, variations in agglutinability.

The non-contact naso-pharyngeal strains, culturally identical with meningococci, exhibited in relation to monovalent agglutinating sera prepared with cerebro-spinal meningococci, the same tendency to grouping as the cerebro-spinal strains and similar variations in agglutinability. The 28 non-contact strains, which have been investigated serologically, reacted to the following extent with one or other of the above-mentioned meningococcus immune sera:—5 showed complete agglutination in 1 : 400 or over, 10 in 1 : 200 or over, 6 in 1 : 100; seven were not completely agglu-

tinated in dilutions higher than 1 : 50. The first-mentioned 5 absorbed, from the respective agglutinating sera, the agglutinins for the homologous strains. From one of these 5, N.P. 10, a serum was prepared which was found to agglutinate strains in Group II. Of the 16 strains which agglutinated with meningococcus sera between 1 : 100 and 1 : 400, a few were tested as to their absorptive capacity in relation to two sera and, as will be seen from the absorption tables, showed evidence of agglutinin absorption. The absorption, though slight in amount, was equal to that occurring with the same sera treated with certain cerebro-spinal strains. The remaining 7 strains, which were agglutinated feebly by the meningoccus sera employed, are being subjected to further investigation (1) as to their agglutinability in relation to other cerebro-spinal meningococcus sera (2) as to their capacity for producing agglutinating sera for cerebro-spinal meningococci. Taken as a whole, the serological results afford indication of a division of meningococci into two groups with some overlapping of each.

The theoretical explanation may be that the antigenic substance of the meningococcus contains one or other of two specific components, A and B, and sometimes contains both components, one of the two then being present in greater amount than the other. Consequently some strains produce sera with agglutinins of the A class alone; others create agglutinins of the B class alone; others produce both A and B agglutinins, with preponderance in some cases of A and in other cases of B. As regards agglutinability, again, some strains are capable of combining with A alone, others with B alone, and others with both A and B, but to a greater degree with the one than with the other.

Comparing the capacity of an individual strain for producing agglutinin with its capacity for combining with agglutinin, I find that in some cases these two capacities appear to coincide. But this is not a general rule. For example, a strain may have limited capacity for combining with agglutinin, but much greater capacity for producing agglutinin; again, it may combine with A alone, or mainly with A, but produce agglutinins in which B preponderates over A.

Absorption experiments, again, show that whilst there is sometimes a correspondence between capacity to absorb and capacity to create, or combine with, specific agglutinin, this correspondence is not a general rule.

These last two considerations show that the characteristics of different strains of meningococci, while affording a basis for division into groups, are closely inter-related, and, in fact, are connected by inseparable links, which appear to make it impossible to effect a definite cleavage between the one group and the other.

The above observations have been suggested by the results so far obtained, but further work on this subject is in progress, with special reference to the identification of the meningococcus in the naso-pharynx.

Conclusion.

All strains of Gram-negative cocci, obtained from the naso-pharynx, identical microscopically, culturally and in fermenta-

tion tests with meningococci, must, in default of a specific test for virulence and until the serological relationships have provided definite evidence to the contrary, be considered to be meningococci.

IV.—A Study of Meningococci occurring in the Spinal Fluid and of Similar Organisms in the Naso-pharynx; by W. M. Scott, M.D.

INTRODUCTION.

The work has been done in the Local Government Board's Pathological Laboratory, and during its course has had the benefit of much advice and criticism from Drs. Eastwood and Griffith, the Board's pathologists.

The task proposed was threefold, (1) to determine the period during which cases of cerebro-spinal fever remain infective, *i.e.*, for how long during convalescence meningococci can be cultivated from the naso-pharynx; (2) to establish if possible the specific identity of meningococci isolated from the cerebro-spinal fluid with those got from the naso-pharynx of the same case; (3) while these pathological throats were being studied, and providing presumably pathogenic meningococci, to search among the flora of the normal, or at least "non-contact" naso-pharynx, for micro-organisms liable to be mistaken for pathogenic meningococci or actually indistinguishable from these. Some opportunity was also afforded for observing whether meningococci were present in the blood stream during the acute stage of cerebro-spinal fever.

The case material was provided by Dr. Foord Caiger, of the Metropolitan Asylums Board South-Western Fever Hospital, to whom I wish to express my very great indebtedness for the large facilities he granted for visiting and examining the cerebro-spinal fever cases under his care.

Dr. A. L. Baly, the Medical Superintendent of the Lambeth Infirmary, was kind enough to allow me to take cultures from the naso-pharynx of "non-contacts" attending his out-patient department.

I have pleasure also in thanking Dr. Arkwright, of the Lister Institute, who gave me cultures of 25 strains of meningococci which he had isolated from the spinal fluid of cases of cerebro-spinal fever during the recent epidemic.

A. Investigation of Cerebro-spinal Fever Cases.

Technique of Culture.

Naso-pharyngeal Cultures.—The examination of the naso-pharynx in all cases was performed personally by abstracting a small portion of mucus from the posterior nares by means of a swab attached to the end of a bent rod, taking care to avoid contamination by the fauces or buccal mucosa. In the case of patients unable to sit up I found it difficult to avoid such contamination, and many of the "negative" swabs recorded during the acute stages of the disease were due to overgrowth of the plates by contaminating organisms.

The mucus abstracted was deposited immediately on freshly poured plates: these were conveyed without delay to the laboratory (usually within one hour), and there the mucus was rubbed over the plate with a right-angled glass rod, this rod being then used for inoculating a second plate of the same medium.

Plates were examined after 24 hours' incubation at 37° C. and again after 48 hours. Suspected colonies were examined first microscopically; when typical micrococci were found a little of the colony was emulsified in sterile saline and used for inoculating tubes of solidified egg, ordinary nutrient agar, ascitic agar, and ascitic agar containing one of each of the following sugars—glucose, maltose, saccharose, and levulose. Strains corresponding culturally with the meningococcus were kept on egg in sealed

tubes at 37° C. On this medium I found that they maintained their vitality for at least four months without subculture, though routine subculture was performed on egg at intervals of one or two months.

Cultures from meningeal fluid were isolated in similar fashion from plates inoculated with the deposit from the centrifuged fluid.

Media Employed for Primary Plates.—Kutscher's serum-agar was always employed. It was prepared from fresh human placenta 500 grams to the litre, a boiled extract being made as with meat after mincing; to this nutrose 2 per cent., glucose 1 per cent., peptone (Chapoteaut) 1·5 per cent., and agar 2·5 per cent. were added, the reaction being brought to + 8 (Eyre) after steaming; this was stored solid in bottles containing 75 c.c., which for use were melted and brought to 50° C.; 25 c.c. of sterile (filtered) ox serum were then added and the mixture poured at once. Comparison with similar agar lacking the placental extract showed that on primary cultivation the meningococcus-like organisms on Kutscher's medium grow more rapidly and produce larger colonies before growth stops.

The medium used for fermentation tests was litmus ascitic agar brought to + 5 (Eyre), the different sugars being added in sterile solution to make 1 per cent. just before sloping.

Microscopical and Cultural Characters.

Microscopically meningococci are micrococci varying considerably in *size* in different strains in primary colonies and showing much variation in size in individuals of the same colony: giant forms are usually present. The *arrangement* is typically diplococcal, usually with distinct flattening of adjacent poles: tetrads are common but not invariably present. The presence of chain formation or pronounced staphylococcal groups rules out a colony as certainly not meningococcal.

Staining in young cultures is distinctly uniform with the exception of the giant forms which often overstain. All individuals are definitely Gram-negative [carbol-gentian-violet ½ minute, Gram's iodine ½ minute, absolute alcohol ½ minute.]

Colonies on Kutscher's agar are highly characteristic. After 24 hours they appear perfectly circular, slightly convex, with a sharp margin, and measure from 1 to 2 mm. across. The colour is pearl-grey, and when viewed by transmitted light they may show slight iridescence: this latter appearance, however, is much more common with colonies from cerebro-spinal fluid than with throat colonies, a fact which may depend on the material inoculated and on the presence or absence of contaminating organisms. The most typical feature, and that on which most reliance was placed, is the fine granularity when viewed under a × 8 lens on the stage of a dissecting microscope and illuminated strongly but obliquely by tilting the mirror so that no direct rays reach the lens.

The consistence is also characteristic: the growth adheres well to the platinum needle without being tenacious; it is not watery nor does the colony break into fragments on touching. The colony is moist and emulsifies readily in water.

After 48 hours the colonies may reach 3 to 4 mm. in diameter but remain perfectly circular: they are less transparent in the centre, but do not become coarsely granular. Some strains acquire a rather characteristic ringed appearance after 24 hours, due apparently to a thinner zone of the colony between the centre and the outer part; these were mostly found to fall into a group, the "Clayton" group, which was distinguishable, as will be seen later, by fermentation and agglutination tests. Some members of this group, however, did not show this ringed appearance. There is never any *pigment* in primary colonies, but subcultures on egg usually show a faint orange-pink colour in the growth collected on a loop. This may even reach a distinct orange or buff colour with certain undoubted strains. Lemon-yellow pigment always excludes a colony; some primary colonies are perfectly colourless, but on subculture develop this pigment and can then be excluded on this as well as on other grounds.

Growth on ordinary agar slopes at 37° C., inoculated with an emulsion from the primary colony, never occurred with any strain which passed the further tests. A certain number of pigmented organisms, however, also failed to grow on ordinary agar.

Growth at 22° C., on tubes similarly inoculated, depends on the medium employed: on ascitic agar it rarely, if ever, occurs, but on Kutscher slopes, as also on egg, definite colonies appear quite frequently in two to four days; on the latter media growth is usually abundant if the inoculation is made with a considerable mass of the colony.

Fermentation.

The characteristic behaviour is fermentation of glucose and maltose only, but it has not been thought justifiable to reject strains which, inoculated from the primary colony, fermented only one of these two substances. Such single-sugar fermenters on later subculture ferment both sugars as a rule, though one may be only slightly attacked. One cerebro-spinal fluid strain, however, fermented no sugar when first isolated, and later fermented glucose only. All the yellow-pigment formers which were isolated fermented levulose in addition to these two sugars, and most of them also saccharose.

Differences in degree of fermentative activity and comparison with agglutination.—Of the cerebro-spinal fluid strains subcultured from primary colonies five fermented glucose more strongly than maltose, seven *vice versâ*, while two fermented them equally. Of the cerebro-spinal fluid strains isolated by Dr. Arkwright, I found that eight fermented glucose more strongly than maltose, eleven *vice versâ* and six equally. Of the strains isolated from the naso-pharynx of convalescent patients nineteen fermented glucose more strongly than maltose, ten *vice versâ* and ten equally.

The glucose-preferring strains showed often but not always the "ringed" type of colonies; they were further separated by the *agglutination* tests which follow and form a fairly definite group, the "Clayton" group (*v. infra*). Most of the maltose-preferring strains and most of the equal-fermenters fell into the "Boscombe" agglutination-group. Exceptions occurred however: one

glucose-fermenting strain fell into the Boscombe group, and several equal fermenters were placed by agglutination in or closely related to the Clayton group. The question of grouping will be discussed after describing the agglutination reactions, but it may be stated that on the strength of observation of the relative activity with which these two sugars were fermented, I could generally predict with which serum the strain would agglutinate.

Agglutination Tests.

Technique of Preparation of Sera.

Monovalent sera alone have been used, and rabbits have been successfully immunised with four *strains*—Boscombe, Clayton, Chandler and Smith. Boscombe and Clayton were strains found in almost pure culture in the *naso-pharynx* of cases of cerebro-spinal fever early in convalescence (1 week and 4 weeks respectively from commencement of the disease). They were chosen as representing the best marked examples in my possession of predominating fermentation of maltose and glucose respectively, the other sugar in each case being only slightly attacked. Chandler and Smith were selected later on the ground of feeble agglutination with Boscombe and none with Clayton serum. They were isolated from the *cerebro-spinal fluid*, Chandler by Dr. Arkwright, Smith by myself. Both fermented maltose and glucose equally strongly.

In the *preparation* of the sera two methods have been used. For Boscombe and Clayton sera prolonged immunisation was employed, but the agglutinating titre was not raised much higher in the succeeding three months of treatment than it appeared ten days after the second injection. In the case of Chandler and Smith sera of equal potency to the above were obtained in a fortnight by giving two maximum intravenous doses at an interval of three days. Ten days later a satisfactory serum was obtained from four of the six animals; two died (one with each strain) 24 hours after the second dose.

The *antigens* in the case of Boscombe and Clayton were living cultures on solidified egg, the dose being raised from $\frac{1}{2}$ a culture to $\frac{2}{3}$, and finally to a whole culture; the injections were made intravenously at intervals of one week. The animals all lost weight during the first two months, but were regaining it during the later stages of immunisation. They were young rabbits of 1,500 grams to 1,800 grams. In the case of Chandler and Smith whole living cultures on Kutscher's slopes were injected intravenously on each occasion.

The titre of all these sera may be stated as complete agglutination of the homologous strain in a dilution of 1 in 600; well-marked agglutination with some remaining turbidity took place at 1 in 800; higher dilutions were not systematically employed.

Failures.—One rabbit of three immunised with Clayton never produced a serum agglutinating completely at a higher dilution than 1 in 200. With two other strains, one from the throat and one from the lumbar fluid, all the rabbits employed (two and three respectively) failed to produce sera agglutinating completely higher than 1 in 200. These sera have not been used for

systematic tests pending repetition of the attempt to produce with the strains sera of higher titre. The failure may depend on poor agglutinogenic properties in the *antigens*, but it must be taken into account that rabbits vary much in their response to immunisation.

Technique of agglutination tests.

The macroscopic method was used throughout and the mixtures were incubated for 24 hours at 55° C.

The micrococcal emulsions were made from glucose ascitic agar cultures of 24 hours' incubation, sown from 24 hours' egg cultures; the growth was washed off with saline, the emulsions thoroughly shaken, allowed to stand for 4 hours and then pipetted off so as to avoid coarse flakes of growth. Such emulsions remain in suspension for 2 to 4 days without producing visible deposit.

Newly-made emulsions, unheated, were used for all tests. All were brought to a standard opacity by comparison with a standard barium sulphate suspension corresponding in opacity to an emulsion containing 10 m.g. moist growth per c.c.

The mixtures were put up in Durham's tubes calibrated so that equal portions were marked off, each containing about 0·3 c.c.; the diluted serum was first put in, then the emulsion run in quickly so as to ensure mixture. A control of normal rabbits' serum diluted 1 in 100 was put up on each occasion with each emulsion.

Variations in agglutination.

Four to five agglutination tests have been made with each strain at intervals of several weeks during which the strains remained in cultivation.

The great majority of the strains kept were very stable throughout both as regards the dilution of a particular serum required to produce complete agglutination and as regards the specificity, *i.e.*, the presence or absence of agglutination with different sera. This stability was no doubt favoured by the fact that the stock was maintained on solidified egg at 37° C., and the sub-cultures employed for agglutination tests, with three exceptions, had not more than three or four sub-cultures intervening between them and the original colony.

None of the strains isolated from the lumbar fluid varied to a greater degree than might depend on small errors in the technique of the agglutination test, with the exception that with one strain, A 2, a gradual increase in agglutinability took place; originally giving only slight clumping with 1–100 Boscombe serum, it increased to complete agglutination at 1–100 and definite clumping at 1–200.

On the other hand one of the South-Western Hospital nasopharynx strains, T 1a, became suddenly inagglutinable or rather incapable of complete agglutination since clumps appeared at as high a dilution as before, but turbidity persisted in the strongest serum. An emulsion prepared from a 24 hours' growth sown from an old stock culture, two "generations" instead of six from the original colony agglutinated to the original titre. The same phenomenon appeared again later with this strain, but was not so well marked. Both A 2 and T 1a were strains sub-cultured more

frequently than the others owing to the fact that they were being used for immunisation, and this may account for the variation.

Four strains developed "auto-agglutinating" properties. In one case by returning to an old stock the original characters were recovered; another strain died out in spite of all efforts to revive it. The two others lost the auto-agglutinating property on further sub-cultivation. All four were throat strains and the appearance of auto-agglutination coincided with evident diminution in the vigour of growth.

Agglutination of spinal strains.

Tables are subjoined recording the results of agglutination tests with 14 strains from the South-Western Fever Hospital, and 25 isolated by Dr. Arkwright. It will be observed that with each serum the maximum dilution is given which produced complete agglutination, *i.e.*, perfectly clear supernatant fluid above the mass of agglutinated cocci; with each serum the homologous strain showed this at 1 in 600. With most strains well-marked clumping, but with some remaining turbidity of the liquid, took place at considerably higher dilutions, this being represented in reading results with the mark + +. Dilutions higher than 1–800 were not used for systematic tests as it was considered that the complete agglutination point was the most satisfactory one for comparison. The + + point is of some value in comparing poor agglutinators where no complete agglutination occurred.

TABLE I.

Agglutination Reactions of Cerebro-Spinal Fluid Strains from South-Western Fever Hospital.

Strain.	Serum Boscombe.		Serum Clayton.		Serum Chandler.		Serum Smith.	
	Highest dilution with complete agglutination.	Highest dilution with agglutination = + +	Highest dilution with complete agglutination.	Highest dilution agglutinating + +	Highest dilution with complete agglutination.	Highest dilution agglutinating + +	Highest dilution with complete agglutination.	Highest dilution with agglutination + +
C.S. 1 ...	600	800	—	—	100	200	600	800
" 2 ...	600	800	—	—	100	200	600	800
" 3 ...	600	800	—	—	200	200	600	800
" 4 ...	400	800	—	—	200	400	200	400
" 5 ...	400	600	—	—	—	100	400	800
" 6 ...	400	800	—	—	—	200	200	800
" 7 ...	600	800	—	50	200	400	600	800
" 8 ...	100	400	—	50	100	200	600	800
" 9 ...	—	100	400	600	—	—	50	100
" 10 ...	—	—	800	800	—	—	—	100
" 11 ...	—	—	400	400	—	—	—	—
" 12 ...	—	—	400	600	—	—	—	—
" 13 ...	—	—	400	600	—	—	—	—
" 14 ...	—	—	200	400	—	—	—	—
Blood 1 ...	—	—	400	400	—	—	—	—

The table shows that strains C.S. 1 to 7 agglutinate strongly with the sera Boscombe and Smith, moderately with serum Chandler and are negative with serum Clayton except for slight agglutination at 1-50 with C.S. 7.

Strain 1 is from the cerebro-spinal fluid of Boscombe, whose naso-pharynx strain was used for preparing the serum of that name.

Strain 8 is Smith and agglutinates accordingly to the full titre with its own serum; it responds rather feebly to Boscombe and Chandler and is almost but not quite negative to Clayton.

Strain 9 agglutinates strongly with Clayton, weakly with Smith, is negative to Chandler and almost but not quite so to Boscombe. Strains 10 to 14 and the blood strain, which was got from the same patient as strain 11, respond strongly to Clayton and are negative to the other three sera with the exception of 10 which reacts very slightly to Smith.

So far, then, a rough but fairly satisfactory grouping into two sets is evident with these strains of cerebro-spinal origin; Boscombe, Chandler and Smith sera pick out eight of the fifteen strains and reject almost but not quite entirely the remaining seven which respond instead to the Clayton serum.

On applying this grouping, however, to a further set of cerebro-spinal strains, those supplied by Dr. Arkwright of the Lister Institute, evidence appears of additional affinities which bring into relationship strains which, on the strength of agglutination with Boscombe and Clayton sera, appear to be sharply distinguishable.

TABLE II.

Comparison with strains supplied by Dr. Arkwright.

Agglutination Reactions of Dr. Arkwright's Cerebro-Spinal Strains.

Strain.	Boscombe.		Clayton.		Chandler.		Smith.	
	Highest complete agglutination.	Highest + + agglutination.	Highest complete.	Highest + +	Highest complete.	Highest + +	Highest complete.	Highest + +
A. 1 ...	400	800	—	—	200	400	200	400
A. 2 ...	100	200	—	—	600	800	200	800
A. 3 ...	600	800	—	—	—	200	800	800
A. 4 ...	600	800	—	—	100	400	400	800
A. 5 ...	600	800	—	—	100	200	400	800
A. 6 ...	800	800	—	—	200	800	400	880
A. 7 ...	200	800	—	—	100	200	800	800
A. 8 ...	600	800	—	—	200	600	400	800
A. 9 ...	400	800	—	—	100	200	400	800
A. 10 ...	200	800	—	—	600	800	200	400
A. 11 ...	600	800	—	—	100	200	400	800
A. 12 ...	600	800	—	—	100	200	400	800
A. 13 ...	200	400	—	—	100	400	400	800
A. 14 ...	400	800	—	—	—	200	400	800
A. 15 ...	600	800	—	100	100	200	400	800
A. 16 ...	200	800	—	—	—	200	200	400
A. 17 ...	400	800	—	—	100	200	800	800
A. 18 ...	400	800	—	—	—	100	400	800
A. 19 ...	—	—	600	800	—	—	—	—
A. 20 ...	—	—	400	800	—	—	—	—
A. 21 ...	—	—	600	800	100	200	—	—
A. 22 ...	—	—	400	800	400	600	—	—
A. 23 ...	—	100	200	400	200	400	—	—
A. 24 ...	—	—	200	800	100	200	400	800
A. 25 ...	—	—	400	800	100	200	400	800

Here again the Boscombe and Clayton sera make a fairly sharp division, there being eighteen responding definitely to Boscombe and not appreciably to Clayton serum, while with the remaining seven the response is exactly reversed.

But among those agglutinated by Boscombe serum, one, A 2, agglutinates weakly, the complete reaction not extending above 1-100. This is Chandler, which provides the serum of the name, and this serum picks out along with fourteen of the Boscombe type four of the Clayton group which it agglutinates on the average quite as strongly.

Further the Smith serum, while it agglutinates all the Boscombe strains fairly strongly, also agglutinates two which are definitely of the Clayton type.

There is evidence thus that it is easy to erect groups among a collection of meningococcal strains on the basis of agglutination with single-strain sera, and it is interesting to note that the fairly definite grouping brought out by Boscombe and Clayton sera coincides very closely with the grouping by means of the fermentation tests referred to above. On the other hand, members of these groups have affinities unrevealed by the particular pair of sera chosen for grouping. In the Table above it is evident that the gap between the well-defined Boscombe and Clayton groups is bridged by the Chandler agglutinated strains and by those agglutinated by serum Smith.

It may eventually be possible to correlate by agglutination tests all the different strains of meningococci which occur in nature and to align them in a series. In such a correlated series the Boscombe and Clayton cultures would occupy opposite ends and be connected with each other by a great number of gradually differing but closely related strains. The central members of the alignment would differ equally widely from both Clayton and Boscombe, while the Boscombe and Clayton type characters would increasingly predominate in the strains towards one or other end.

Agglutination Reactions of Meningococcus-like Organisms in the Naso-pharynx of Convalescents.

Table III. expresses the behaviour as regards agglutination with the same four sera of strains of micrococci which produced characteristic colonies on plates inoculated from the naso-pharynx of convalescents and which microscopically and culturally were indistinguishable from the meningococcus. No strain which passed the morphological and cultural tests failed to give complete agglutination with one or more sera diluted 1-100.

Each arabic numeral represents an individual patient while the letters attached indicate that the strain was isolated from the same patient on different occasions, the dates of which from the time of admission to hospital are given in the second column. Further, an additional column not included in previous tables is devoted to recording with each serum its agglutinating effect when diluted 1 in 100. The sign " + + + " indicates that agglutination was almost but not quite complete, faint turbidity persisting, while " + " indicates clumping present but not well-marked. The " + + " mark indicates, as before, well-marked agglutination with a good deal of turbidity persisting.

TABLE III.

Naso-pharyngeal Strains from South-Western Fever Hospital. Cases of Cerebro-spinal Fever and Contacts.

No. of case.	Period after admission at which strain was isolated.	Boscombe serum.			Clayton serum.			Chandler serum.			Smith serum.		
		Highest complete.	Highest ++	Agglutination at 1-100	Highest complete.	Highest ++	Agglutination at 1-100	Highest complete.	Highest ++	Agglutination at 1-100	Highest complete.	Highest ++	Agglutination at 1-100
T. 1*a*	6 days ...	600	800	c	—	—	+	100	200	c	600	800	c
T. 1*b*	2 months	—	100	++	—	100	++	200	600	c	—	100	+++
T. 1*c*	10 weeks	—	100	++	100	200	c	200	400	c	100	200	c
T. 1*d*	3 months	—	100	++	—	200	+++	—	100	++	200	800	c
T. 2*a*	3 weeks	400	600	c	—	—	trace	—	—	+	—	100	++
T. 2*b*	5 weeks	400	600	c	—	—	+	—	—	+	—	200	+++
T. 2*c*	7 weeks	400	600	c	—	100	++	—	200	+++	400	800	c
T. 3*a*	10 days	200	400	c	—	—	—	100	...	c	600	800	c
T. 3*b*	3 weeks	400	600	c	—	—	—	...	...	...	...	...	...
T. 4*a*	6 days	600	800	c	—	—	—	—	100	++	400	800	c
T. 4*b*	2 weeks	—	—	+	400	800	c	...	...	...	...	...	...
T. 4*c*	4 weeks	—	—	+	400	800	c	...	...	...	...	...	...
T. 4*d*	7 weeks	—	—	—	600	800	c	—	100	++	—	200	+++
T. 4*e*	8 weeks	—	—	—	400	800	c	...	...	...	...	...	...
T. 5	5 days	600	800	c	—	—	—	—	—	+	100	400	c
T. 6*a*	9 days	400	600	c	—	100	++	—	200	+++	400	800	c
T. 6*b*	40 days	400	600	c	—	—	+	—	200	+++	400	800	c
T. 7	2 days	200	800	c	—	—	+	100	200	c	600	800	c
T. 8	1 day	—	—	trace	200	400	c	—	100	++	100	200	c
T. 9	Contact, 3 weeks.	—	—	—	400	800	c	—	—	trace	—	—	trace
T. 10	3 weeks	—	100	++	200	600	c	—	100	+++	—	100	+++
T. 11*a*	6 weeks	—	—	trace	100	200	c	—	—	—	—	—	—
T. 11*b*	7 weeks	—	—	—	200	400	c	—	—	trace	—	—	+
T. 12*a*	4 days	—	—	+	600	800	c	—	100	++	—	200	+++
T. 12*b*	3 weeks	—	—	—	400	800	c	—	—	+	—	100	++
T. 13*a*	4 weeks	—	—	trace	600	800	c	—	—	—	—	—	—
T. 13*b*	5 weeks	—	—	—	600	800	c	—	—	—	—	—	—
T. 13*c*	6 weeks	—	—	+	600	800	c	—	—	+	—	—	+
T. 13*d*	7 weeks	—	—	—	600	800	c	—	—	+	—	—	+
T. 13*e*	8 weeks	—	—	+	600	800	c	—	—	—	—	—	+
T. 13*f*	9 weeks	—	—	—	600	800	c	—	—	—	—	—	+
T. 14	3 weeks	—	—	+	200	400	c	—	—	—	—	—	—
T. 15	10 days	—	—	—	100	200	c	—	—	—	—	—	—
T. 16	4 weeks	100	200	c	—	—	+	—	—	+	—	—	+
T. 17*a*	Contact, 2 weeks.	—	—	+	200	400	c	—	—	+	—	—	+
T. 17*b*	Contact, 3 weeks	—	—	+	200	400	c	—	—	+	—	100	++
T. 18	Contact, 3 weeks	—	—	—	100	200	c	—	—	+	—	100	++
T. 19	Contact, 2 months	—	—	trace	400	600	c	—	—	—	—	100	++

It will be seen that 12 of the 38 strains agglutinate most strongly with Boscombe serum, while 23 strains agglutinate most strongly with the Clayton serum; two strains agglutinate most strongly with Chandler and one with Smith.

Of those agglutinating completely with Boscombe one does not do so higher than at 1–100, but all but two of the others reach 1–400, while ten of those agglutinated completely by Clayton serum do not exceed the level of 1–200. Four of these last were from contacts with no meningeal symptoms who presented doubtful if any clinical evidence of naso-pharynx infection. The possi-

bility will be shown later, when discussing non-contacts, that some of these strains were not abnormal inhabitants of the naso-pharynx.

Persistence of Meningococci in the naso-pharynx of cases of Cerebro-spinal Fever.

In 16 cases regular examination of the naso-pharynx was possible. In 8 of these, patients 1, 2, 4, 10, 11, 12, 13, 16, meningococcus-like organisms were got up to the end of treatment in hospital and were still presumably present on discharge, in one case after over 3 months, after 9 weeks in another, and 7 weeks in 3 others; the periods at which meningococci were found are shown in Table III.

Thus in 50 per cent. of cases complete convalescence occurred before the naso-pharynx was free; the maximum period of persistence of meningococci was not determined but evidently exceeded 3 months.

In five cases negative results were obtained on all (at least two) successive examinations after positive results had been established; the last positive result was on the fifth day in one case and at various periods up to five weeks in the others: *vide* Table III., patients 3, 5, 6, 7 and 15. In the three remaining, undoubted cases of disease, no meningococcus-like organism was found in the naso-pharynx either during the acute stage or at any of five weekly examinations thereafter.

Cases 8, 9 and 14 on Table III. presented doubtful symptoms of cerebro-spinal fever, but were not established as cases of the disease, spinal puncture not having been performed.

Cases 17 and 18 were contacts of the disease, but presented indefinite symptoms only and were not tapped, while case 19 was an enteric fever patient nursed in the same ward as the cerebro-spinal fever cases.

In addition, 23 patients from the cerebro-spinal fever wards were swabbed once with negative results; 10 of these were in advanced convalescence from the disease when first seen and 13 were enteric fever patients. These were the first swabs I took, and the negative results may in part be ascribed to lack of experience in examining plates from the naso-pharynx; the smaller colonies which later experience showed to be meningococcal might have been overlooked.

Meningococci in the Blood Stream.

Three attempts at cultivation of meningococci from the blood were made in three acute cases; two of these failed in spite of having incubated 9 c.c. of blood in 200 c.c. of serum broth. From the third, the most acute and eventually a fatal case, cultures were easily got by direct inoculation of a few drops of blood on slopes of Kutscher's agar. The strain thus isolated agreed in all respects with that obtained from the spinal fluid of the same case. Microscopical examination of the blood in this and five other acute cases was entirely negative as regards the appearance of diplococci within or without cells.

Comparison of Strains cultivated from the Spinal Fluid and the Naso-pharynx of the same patient.

This was possible in seven cases; the spinal strains being, in Table I., strains C.S. 1, 2, 4, 5, 7, 8, and 10, while the naso-pharynx strains corresponding are, in order, T 1 (a, b, c and d), T 2 (a, b and c) T 3 (a and b), T 4 (a, b, c, d, and e), T 6 (a and b), T 15, and T 12 (a and b).

It will be seen that in all but the pair C.S. 8 and T. 15 a strain was isolated from the naso-pharynx corresponding closely in specific agglutination with that got from the spinal fluid. In four cases no other specific type than that found in the spinal fluid was cultivated from the throat.

In two cases, however, the pairs C.S. 1 with T 1 and C.S. 5 with T 4, only the first positive swab furnished a strain agglutinating like the spinal strain.

T 1 a, like C.S. 1, was a strongly agglutinated "Boscombe" strain; T 1 b, c, and d were very feebly agglutinated by "Boscombe" serum, but the first two agglutinated fairly well with "Chandler" serum and the last with "Smith" serum.

T 4 a, like C.S. 5, was similarly of the Boscombe type, but T 4 b, c, d, and e were almost pure Clayton strains agglutinating almost to the full titre of this serum and feebly or not at all with all other sera.

The question is raised by these results whether modification may go on in the naso-pharynx so that one type changes into the other. It is noteworthy that the plates from which these strains were obtained showed almost pure cultures of colonies indistinguishable from those picked for isolation of the strains.

An alternative hypothesis is that the later swabs were furnishing cultures of another, perhaps a normal, inhabitant of the naso-pharynx which had been swamped by the infecting strain at the time of the first examination.

The strain T 15 which is also different from its spinal strain C.S. 8 raises the same question, but in this case the homologous strain was not recovered from the naso-pharynx, only the variant.

B. Investigation of Non-contacts.

Meningococcus-like Organisms in the Naso-pharynx of Non-contacts.

The observations just discussed lead up to the question whether organisms resembling meningococci may be normal inhabitants of the naso-pharynx.

Among the Lambeth Infirmary out-patients from June 1st to July 15th, 1915, 150 swabs were taken, 38 from males, 112 from females; 12 of these were repeat swabs, 11 being seconds and 1 third. Of a total of 138 individuals 19 ($13\frac{1}{2}$ per cent.) were of 14 years or under, while 66 (47·8 per cent.) were of 50 or over.

Twenty-six were normal individuals, the rest suffered from various ailments—chronic coughs, rheumatism, "bad legs," etc. No connection with cases of cerebro-spinal fever could be discovered with any.

Thirty-five swabs yielded colonies *culturally* and *microscopically* indistinguishable from the meningococcus. Of these, however, 2 were repeats reducing the percentage of individuals with such suspicious organisms to 24 per cent. Of these, moreover, three eventually developed abnormalities necessitating their exclusion, so that the final percentage of "positives" on the strength of microscopical and cultural characters was 22 per cent.

The colonies were noted as being in "almost pure culture" in 2 cases, "numerous" in 15 cases, "few" in 8 cases, while in 10 cases a single suspicious colony was found on the plates.

Cultural Characters and Fermentation Tests.

Colonies selected were those showing sharply defined round outline, slightly raised towards centre, pearly grey in colour, translucent and with characteristic fine granularity when illuminated obliquely from below under 8 × lens.

With few exceptions on plates of 24 hours they were *smaller* and *slightly more opaque* than the meningococcus colonies isolated from the naso-pharynx of convalescent C.S.F. patients and in only two instances presented the bluish tint by transmitted light characteristic of colonies grown from the lumbar fluid. After growing for 48 hours the differences above noted were less marked, though the opacity was still rather greater in most cases.

A good many other colonies were sub-cultured as being doubtful, but not definitely distinguishable; these fermented other sugars (levulose and saccharose), grew on first sub-culture on ordinary nutrient agar, showed good growth on ascitic agar at 22° C. in two days, and were hence not further studied.

Of the 35 strains kept for further study, 2 were lost before all the tests were complete, while 2 began to develop traces of pigment on successive sub-cultures and were then found to ferment levulose in addition to glucose and maltose. A fifth without developing colour was found later to ferment levulose. The last three were tested along with the "normal" strains as regards agglutinating properties. They were entirely negative with all sera used.

Slopes of litmus ascitic agar containing the various sugars in 1 p.c. strength were inoculated direct from suspected colonies. The results were as follows: of the 35 strains kept, 12 fermented glucose more strongly than maltose, 5 fermented maltose more than glucose, while 16 were apparently equal, and 2 fermented glucose only. Saccharose, levulose and galactose were not fermented by any. On repeating the fermentation tests after five to six months' sub-culture on egg the following results were got:—(1) 3 strains now fermented levulose, 2 by this time being known as pigment-producers (yellow), the third not pigmented; (2) no strain which formerly preferred glucose to maltose now preferred maltose to glucose and vice versâ, *i.e.*, there were no reversed activities; (3) none of the previously equal fermenters now preferred glucose; (4) but 10 of these equal fermenters now preferred maltose; (5) 3 of those formerly preferring glucose now fermented maltose equally well; (6) 2 of those preferring maltose but also

fermenting glucose now fermented maltose only. There was evidently a general increase in the maltose fermenting power as compared with glucose. The medium employed at the second examination differed in the ascitic fluid being of a different sample, but was in reaction as nearly as possible the same, + 5.

Agglutination Reactions.

The thirty surviving strains were tested as regards agglutination with the same four sera as in the previous tests and the results are shown below.

TABLE IV.

Titre of each serum with its own strain = complete agglutination at 1–600.

Strain.	BOSCOMBE.			CLAYTON.			CHANDLER.			SMITH.		
	Highest dilution with complete agglutination.	Highest dilution with agglutination = ++	Agglutination at 1–100.	Highest dilution with complete agglutination.	Highest dilution with agglutination = ++	Agglutination at 1–100.	Highest dilution with complete agglutination.	Highest dilution with agglutination = ++	Agglutination at 1–100.	Highest dilution with complete agglutination.	Highest dilution with agglutination = ++	Agglutination at 1–100.
T.N. 1 ...	—	—	trace	—	—	+	—	—	o	200	400	c
T.N. 2 ...	200	400	c	—	100	++	—	—	o	100	200	c
T.N. 3 ...	—	100	++	100	200	c	—	—	—	100	200	c
T.N. 4 ...	—	—	o	—	—	+	—	—	o	—	—	o
T.N. 5 ...	—	—	trace	100	200	c	—	—	o	—	—	+
T.N. 6 ...	—	—	o	—	—	+	—	—	o	100	200	c
T.N. 7 ...	—	—	+	100	200	c	—	—	o	100	200	c
T.N. 8 ...	—	—	o	—	200	+++	—	—	o	—	—	+
T.N. 9 ...	—	—	trace	—	100	++	—	100	++	200	300	c
T.N. 10 ...	—	100	+++	—	—	o	—	—	o	—	—	+
T.N. 11 ...	—	—	o	—	100	++	—	—	trace	100	200	c
T.N. 12 ...	—	—	o	200	400	c	—	—	o	—	—	o
T.N. 13 ...	100	200	c	—	100	++	—	—	o	200	400	c
T.N. 14 ...	—	—	+	100	200	c	—	—	o	100	200	c
T.N. 15 ...	—	—	o	200	400	c	—	—	o	100	200	c
T.N. 16 ...	—	—	o	200	400	c	—	—	o	—	—	+
T.N. 17 ...	—	—	o	400	800	c	—	—	o	—	—	+
T.N. 18 ...	—	—	o	—	100	++	—	—	o	—	—	+
T.N. 19 ...	—	—	o	—	—	+	—	—	o	—	—	+
T.N. 20 ...	—	—	trace	200	400	c	—	—	o	—	—	trace
T.N. 21 ...	—	—	o	—	—	+	—	—	+	100	200	c
T.N. 22 ...	—	—	trace	—	100	+++	—	—	+	100	200	c
T.N. 23 ...	—	—	trace	100	200	c	—	—	o	—	—	+
T.N. 24 ...	—	—	o	—	100	+++	—	—	o	—	—	trace
T.N. 25 ...	—	—	o	—	100	++	—	—	o	—	—	trace
T.N. 26 ...	—	—	o	—	—	trace	—	100	+++	—	—	+
T.N. 27 ...	—	—	trace	—	100	++	—	—	o	—	—	o
T.N. 28 ...	—	—	o	—	100	++	—	—	o	100	200	c
T.N. 29 ...	—	—	o	100	—	c	—	—	o	100	200	c
T.N. 30 ...	—	—	trace	—	100	+++	—	—	o	100	200	c

The symbol " + " signifies definite but slight agglutination; the symbol " + + " means well-marked but incomplete agglutination, while " + + + " means agglutination almost complete but with a trace of turbidity persisting.

It will be seen that 5 strains were completely agglutinated at 1–200 or over with "Clayton" serum; of these 1 was also complete at 1–100 with "Smith" serum, while the other 4 were negative with all other sera. Six strains were complete with Clayton serum at 1–100, and of these 4 were also complete at the same dilution with Smith serum, the other 2 with no other serum than Clayton.

One strain was complete at 1–200 with Boscombe and at 1–100 with Smith, while one was complete at 1–100 with Boscombe, and at 1–200 with Smith.

Three strains were complete at 1–200 and 12 at 1–100 with Smith.

Nine strains were not completely agglutinated with any serum, but showed some clumping at 1–100, 7 with Clayton serum, and 1 each with Boscombe and Chandler.

If these 9 are excluded as showing insufficient agglutination to justify their position as meningococci, there are 21 strains which could not readily be thrown out of the meningococcus category. Of these, 13—14 and 16—17 are pairs from the same throat at different examinations. There are, after deducting these, 19 individuals in whose naso-pharynx organisms were found identical or closely related to the meningococcus as shown by microscopical, cultural and serological tests; this is equivalent to 13·7 per cent. of the throats examined at Lambeth.

Of the males examined, (32), 15·6 per cent. were positive, while 13·2 per cent. of the females (106) were positive. Of those of 50 years and over 18·2 per cent. were positive, while of those between 14 and 50 years 11·3 per cent. were positive.

Only 1 "positive" was found among children under 14, of whom 19 were examined (5·3 per cent.).

Non-contact school children.

Fifty-six children of ages from 5 to 13 attending a rural school were examined early in May. One plate only showed "suspicious" colonies, giving a strain whose morphological, cultural and fermentative characters were meningococcus-like. It gave a "trace" of agglutination with serum "Smith" at 1–100, but with no other serum.

Agglutinin-Absorption Experiments.

Further evidence of serological relationship of the above organisms to meningococci was sought by estimating their capacity of absorbing the specific agglutinins.

The growth was scraped from 48-hour glucose ascitic agar plates sown with the strains to be examined, weighed moist, mixed with Clayton serum diluted 1–50, so that each c.c. of the mixtures contained 40 m.g. of growth. The mixtures were incubated 18 hours at 55° C., centrifuged, and the clear (or in some cases opalescent) fluid used as an agglutinating serum of 1–50 dilution. A control specimen of the diluted serum was similarly heated and centrifuged.

The results are recorded in the following table.

TABLE V.

Absorption of Agglutinin from Serum Clayton.

Test Emulsions.	Treatment of Serum.	Agglutinations. 1–100	1–200	1–400	1–600	1–800
T. 13c (Clayton)	Control showing titre without exhaustion.	c	c	c	c	+++
T.N. 17 ...		c	c	c	+++	+
T.N. 12 ...		c	c	++	+	o
T.N. 4 ...		+	o	o	o	o
T. 13c (Clayton)	Serum Clayton exhausted with T. 13c (Clayton)	trace	o	o	o	o
T.N. 17 ...		trace	o	o	o	o
T.N. 12 ...		trace	o	o	o	o
T.N. 4 ...		o	o	o	o	o
T. 13c (Clayton)	Serum Clayton exhausted with T.N. 17	+	o	o	o	o
T.N. 17 ...		trace	o	o	o	o
T.N. 12 ...		o	o	o	o	o
T.N. 4 ...		o	o	o	o	o
T. 13c (Clayton)	Serum Clayton exhausted with T.N. 12.	+++	++	o	o	o
T.N. 17 ...		++	o	o	o	o
T.N. 12 ...		o	o	o	o	o
T.N. 4 ...		o	o	o	o	o
T. 13c (Clayton)	Serum Clayton exhausted with T.N. 4.	c	c	+++	++	++
T.N. 17 ...		c	c	++	+	o
T.N. 12 ...		c	+++	+	+	trace
T.N. 4 ...		o	o	o	o	o
T. 13c (Clayton)	Serum Clayton exhausted with T. 1 (Boscombe).	c	c	c	c	++
T.N. 17 ...		c	c	c	++	+
T.N. 12 ...		c	c	+	+	o
T.N. 4 ...		+	o	o	o	o

The table shows that the non-contact throat strains T.N. 17 and T.N. 12, which are well agglutinated by Clayton serum, also absorb the agglutinin for the strain with which Clayton serum was prepared, as well as the agglutinin for themselves, and this to almost the same extent as the homologous strain does with the same serum. Another strain, T.N. 4, which is agglutinated, as shown above, only to the smallest degree by Clayton serum, absorbs a just perceptible amount of agglutinin, while a non-agglutinating meningococcus strain, T. 1 (Boscombe), absorbed practically none.

Four other similar experiments were made with similar results which may be summarised thus: five known meningococcus strains and nine non-contact strains were treated with Clayton and with either Boscombe or Smith sera, *i.e.*, sera of another type; Clayton and Boscombe strains (which do not agglutinate at all with each other's sera) did not absorb agglutinin from each other's sera: agglutinability and absorptive capacity for agglutinin ran parallel: with the relatively weakly agglutinated strains increase in the quantity of the bacterial growth used for absorption increased the amount of agglutinin removed. There was no adequate evidence of a "group agglutinin" in the sense of one which could be removed by absorption with a related strain leaving the more "specific" agglutinin intact.

Complement—Fixation Experiments with Strains from Cases of Cerebro-spinal Fever and from Non-contacts.

Two sets of these were done: in the first, with an *extract* from meningococcal growths as antigen, the specific complement absorption was slight in amount and not in agreement in every case with the agglutination reactions. For example, T 1 absorbed a little complement in combination with the non-agglutinating Clayton serum and no more with its homologous serum. TN 17, however, was consistent, as it absorbed 5 doses of complement in combination with Clayton serum and less than one with Boscombe serum.

In the second experiment the antigens used were *heated emulsions* [65° C.], and the results were parallel as regards specificity with the agglutination tests; ·05 c.c. of the agglutinating sera with ·2 c.c. of bacterial emulsion took up 4 to 5 doses of complement, while the non-agglutinating sera in similar amounts took up one to two doses only.

SUMMARY.

(1) The maximum period during which meningococci may be isolated from the naso-pharynx of convalescents exceeds three months.

(2) Meningococci were isolated from the naso-pharynx and proved identical with those isolated from the spinal fluid of the same patient in 7 cases.

(3) In two of these cases the type of meningococcus found in the naso-pharynx at first resembled exactly that found in the spinal canal of the same patient, and later was persistently replaced by a meningococcus differing markedly in serological reactions from the spinal strain.

(4) Micro-organisms indistinguishable from meningococci by microscopical and cultural methods (including fermentation tests) were found in the naso-pharynx in 22 per cent. of 138 individuals, non-contacts, from an urban population (Lambeth out-patients).

(5) With 63 per cent. of these organisms the serological tests confirmed their identity with or close relationship to meningococci; they agglutinated specifically with anti-meningococcus serum and exhibited a tendency to fall into the same serological groups as the spinal strains.

(6) Their agglutinating properties were not, in general, so strongly marked with the sera used as those of the known pathogenic strains but they showed definite absorption of the specific agglutinin. They appeared to differ from the majority of the spinal strains not in the quality but in the quantitative intensity of their specific affinities: some spinal strains, however, resembled them in this.

(7) Thus, in 13·7 per cent. of the 138 non-contacts microorganisms were found in the naso-pharynx indistinguishable by any test from strains of meningococci known to have caused meningitis: these are regarded by the writer as meningococci and the individuals harbouring them as meningococcus-carriers.

V.—Report on Cerebro-Spinal Fever and its epidemic prevalence among the civil population in England and Wales, with special reference to outbreaks in certain districts during the first six months of for the year 1915. By Dr. R. J. Reece.

Cerebro-spinal Fever.

An historical account of the behaviour of cerebro-spinal fever throughout the world has been written by my colleague, Dr. R. Bruce Low, and in his report he deals generally with occurrences of the disease in this country. Here it is only necessary to state that, although in comparatively recent years the disease was recognised in the British Isles as occurring sometimes as sporadic cases and at other times in small groups of cases, it appeared in epidemic form at Dublin in 1886, at Glasgow and Belfast in 1907, and at Swansea in 1908.

Confusion in diagnosis between cerebro-spinal fever and acute poliomyelitis when the latter illness appeared in epidemic proportions in this country in 1910 and 1911*, together with the fact that study of the death returns of the Registrar-General showed that the numbers of deaths registered as due to cerebro-spinal fever and diseases affecting the cerebro-spinal system were on the increase, led to these two diseases being made compulsorily notifiable on September 1st, 1912, throughout England and Wales. Prior to this date cerebro-spinal fever had been added to the list of notifiable diseases under the Infectious Diseases (Notification) Act, 1889, by certain sanitary authorities: in London it was made a compulsorily notifiable disease in 1907.

In the Manual of the International List of Causes of Death, as adapted for use in England and Wales, the deaths referable to "meningitis" are returnable under three sub-headings—61. A. Cerebro-spinal fever, shown under four different terms; 61. B. Posterior basal meningitis shown under five terms; and 61. C.

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* Supplement to the forty-first Annual Report of the Local Government Board, containing the Report of the Medical Officer for 1911–12.

Meningitis—other forms—of which 20 different terms are scheduled. Tuberculous meningitis, or any synonym of this term, and rheumatic meningitis, are not included in this category.

There is some reason for the belief that in certain cases deaths attributed to posterior basal meningitis have in reality resulted from infection by the diplococcus intracellularis of Weichselbaum, now generally termed meningo-coccus; and Dr. Stevenson, in the review of the vital statistics in the Registrar-General's Annual Report for 1913, calls attention to the fact that deaths due to meningococcic meningitis may have been returned as meningitis, and in consequence have been recorded under the classification of "Meningitis—other forms."

This inference is undoubtedly correct in the absence of bacteriological verification of many cases of "meningitis," and the official returns can only be accepted as approximately correct. Nevertheless, they indicate in no uncertain fashion that cerebro-spinal fever has been an increasing cause of death during recent years in England and Wales. This is shown in the following table, taken from the Registrar-General's Annual Reports:—

Deaths from Cerebro-Spinal Fever in England and Wales and in London.

——	1901	1902	1903	1904	1905	1906	1907
England and Wales	59	60	68	81	127	71	161
London	17	13	7	21	26	14	50

——	1908	1909	1910	1911	1912	1913	1914
England and Wales	116	130	132	134	142	163	194
London	35	35	30	26	25	24	24

In consequence of the disease becoming compulsorily notifiable throughout the country, it was considered desirable for the medical department of the Board to make inquiry in regard to these cases, until such time as the medical profession should become accustomed to the new arrangements. The result has been that the initial returns of notified cases have been revised, but the revision has not materially affected the total number of notified cases. Certain cases have been withdrawn in consequence of revision of diagnosis, others have been deleted as dual notifications, and some cases have been added which had escaped notification. It is possible that even the revised number of cases falls short of those that have occurred, though the number remaining un-notified is probably small.

Thus, in the year 1912, during the greater part of which cerebro-spinal fever was not compulsorily notifiable throughout the whole country, 267 cases were known to have occurred, and particulars of 250 of these cases were obtained. In the years 1913 and 1914 the disease was compulsorily notifiable throughout

the whole country; 279 cases occurred in 1913, and particulars were obtained of 276 of these cases and of the 300 cases which occurred in 1914. From the information obtained in regard to these cases the percentage of attacks on males and females, the percentage of cases in age groups, and the fatality per 100 cases are known for 826 cases, and are shown in the table below. It should be borne in mind that the figures only relate to the civil population:—

Year.	Number of known attacks.		Percentage of total attacks.		Percentage of total cases in age groups.			Fatality per 100 cases.
	Male.	Female.	Male.	Female.	0–5	5–15	15+	
1912...	139	111	55·6	44·4	46·8	27·6	25·6	70·0
1913...	154	122	55·8	44·2	43·1	35·1	21·8	69·6
1914...	173	127	57·7	42·3	51·3	31·3	17·3	68·7

These figures indicate that during the three years under review the total number of cases throughout England and Wales show that, taking the period as a whole, the disease was in no sense epidemic, that the greatest incidence fell on children under 15 years of age (from 74 to 82 per cent.), that males suffered more than females, and that the case fatality was high.

While, on the one hand, the statistics of the last few years called for no cause for alarm in regard to prevalence of cerebro-spinal fever, nevertheless they showed an increasing amount of the disease.

The outbreak of war in the summer of 1914 brought about a redistribution of the population. Young men of military age, joining the Colours, became grouped in camps, and troops were concentrated in various parts of England for military reasons. On the advent of winter many of the troops were billeted on the civil population.

Overcrowding in barracks, in "hutments," and in billets took place, pending such time as it became possible to make suitable arrangements for the accommodation of large bodies of troops.

Cerebro-spinal fever has been termed by competent observers abroad as a disease of children and recruits. The result of the altered conditions was keenly watched, and by the end of the year 1914 it became manifest that cerebro-spinal fever in epidemic form had to be reckoned with.

The disease, as known in the civil population of England and Wales until the end of the year 1914, was mainly an affair of large towns and of populations aggregated in urban districts. Its distribution in the civil population in counties, and its sub-distribution for the years 1912, 1913 and 1914 is shown in Table I. in the Appendix.

From this table it will be seen that the counties which have their population grouped in the main in county boroughs, boroughs and urban districts—Lancashire and the West Riding of York-shire—furnish the greater number of cases. But the annual pro-

portion of cases to population in London (·019 per 1,000) is more than twice as great as that of Lancashire (·008) and nearly four times that of the West Riding (·005).

Most of the cases in Gloucestershire occurred in the City of Bristol.

Wales shows a remarkable absence of the disease; the few cases that occurred being almost without exception in the populous parts of Glamorganshire and Monmouthshire.

Though generally distributed, in no place can the disease be said to have been epidemic.

The seasonal distribution of the cerebro-spinal fever cases among the civil population during the last four months of the year 1914 is shown in Table II. in the Appendix. It shows that by far the larger number of the places affected were county boroughs. It was not until after the week ending 12th December, 1914, that notified cases among the civil population, viz., those occurring in the City of Salisbury, the Wilton Urban and the Hambledon and Pewsey Rural Districts, were associated with military cases.

Cerebro-Spinal Fever in the first six months of the year 1915.

The cases of cerebro-spinal fever which have been notified during the first six months of the year 1915 are shown in Table III. in the Appendix. The table is compiled from the weekly returns of the medical officers of health of the sanitary districts in the country. These returns can be accepted in broad fashion as indicating the general distribution of the disease throughout the country and its seasonal prevalence. From the table the advent of the disease in different parts of the country can be traced. The notifications are shown under the headings of county boroughs, urban and rural districts. The figures, however, are not to be accepted as absolute, for in certain instances the diagnosis has been revised subsequently and the case withdrawn. Military cases occurring in billets have been occasionally notified without the distinction having been made that the patients were soldiers. In some cases there have been dual notifications, as, for instance, when a case occurs in one district and is moved into an isolation hospital situated in another district. It has not been found possible to make the necessary corrections for the whole of the country, but the careful records kept by many medical officers of health of towns, especially of such towns as Bristol, Salisbury and Portsmouth, which have been closely associated with military cases, and in others, such as Manchester and Liverpool, which have been affected to a lesser extent, have enabled the necessary corrections to be made. The figures, however, in the table stand as originally notified.

It will be seen from Table III. that 22·9 per cent. of the whole of the cases notified in England and Wales occurred in the area of the London County Council. The distribution of the disease in the several metropolitan boroughs is shown in Table IV. in the Appendix.*

* This table and the table relating to the age and sex distribution of the London cases have been prepared from information kindly supplied by Dr. Hamer, M.O.H., London County Council.

It will be seen from Table IV. that while the incidence of the disease in the first six months of the year 1915 has been more than five times as great as the average yearly attack rate for the three preceding years, the cases have been spread over the whole of the area of the London County Council; the City of London alone escaping attack.

The age and sex distribution is shown for each of the metropolitan boroughs in Table V. in the Appendix.

It will be seen from this table that, while the incidence of the disease is fairly equally distributed between the two sexes, with the exception of those under one year of age, in which group the males suffer an undue proportion of attack, the incidence on the several age-groups varies within wide limits, diminishing progressively as age advances. Thus, 40·4 per cent. of the total cases were under 5 years of age, 18·2 between 5 and 10 years, 10·7 between 10 and 15, 8·8 between 15 and 20, and 22·0 per cent. over 20 years of age. This distribution of cases of cerebro-spinal fever in age groups will be materially modified when the cases which have occurred in the military population are included.

Cerebro-Spinal Fever in Wiltshire.

Although the first military case which happened after the date of mobilisation (5th August, 1914) occurred at Great Bentley, in Essex, the patient exhibiting the first symptoms of his illness on 19th September, interest centres in Wiltshire, where the Canadian Expeditionary Force was stationed.

In Wiltshire during the year 1914 the following cases of cerebro-spinal fever were notified among the civil population:—

Week ending	8th August, 1914 ...	Calne Urban District ...	1 case.*
,, ,,	15th August, 1914 ...	Mere Rural District ...	1 case.†
,, ,,	19th December, 1914.	Salisbury City	1 case.
		Wilton Urban District ...	1 case.‡
,, ,,	26th December, 1914.	Salisbury City	2 cases.§
		Pewsey Rural District ...	1 case.
,, ,,	2nd January, 1915 ...	No cases in Wiltshire	

Four cases of cerebro-spinal fever had occurred among these Canadian troops while in camp at Valcartier in Canada, three cases had occurred on the transports during the voyage, and the first case after arrival in England was attacked on 18th October.

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* A female child, aged 5, was notified as suffering from cerebro-spinal fever on 8th August, 1914, in the Calne Urban District; she recovered. No history of any source of infection was traced, but a fatal case of meningitis had previously occurred in the district, and this raised a suspicion that the disease might be cerebro-spinal fever.

† The case in the Mere Rural District occurred at Maiden Bradley. The patient, a male child under 5 years of age, was taken ill on 8th August, 1914, before any soldiers were billeted in the neighbourhood. The patient died. No further cases occurred in the locality.

‡ The case which occurred in the Wilton District was a girl aged 7, who was attacked on 18th December, 1914. She ultimately recovered. Her father was constantly in the camps and supplied the soldiers with drapery, but there was no definite history of contagion as regards the child.

§ There was only one case, the second notification was due to the case from the Pewsey Rural District being taken into hospital in the city, and notified therefrom.

The Canadian troops were encamped on Salisbury Plain, where also were encamped a large number of British troops. This military camp stretches over a considerable area, and it is sub-divided into many camping areas. The civil sanitary districts within this area are the Pewsey and the Amesbury Rural Districts in Wiltshire and the Andover Rural District in Hampshire. Salisbury City is several miles distant from the confines of the camp, but it is the nearest large town and the natural centre for general shopping, and it is on the main railway line to London. The Headquarters of the Southern Command are at Salisbury.

At the Census of 1911 the population of the city was 21,217 persons, but following mobilisation the city became a busy centre. New camps were formed on the Plain and many hutments erected. The normal population of the city became greatly increased by camp workers, who slept the night in Salisbury, going to and returning from the camps, and this number was again increased at the week-ends. These workers were composed of skilled workmen of varying trades and casual labourers, and some undesirable persons.

Three cases were notified among the Canadian troops on 27th and 30th October, and the 4th November, respectively. These cases and the first case (October 18th) all occurred in the Amesbury Rural District. The next military case occurred among the British troops quartered at Netheravon, in the Pewsey Rural District. The distribution of these cases into sanitary areas is of little importance, for the boundary line between the Amesbury Rural District and the Pewsey Rural District passes through some of the camps, which hereabouts can be regarded as a group of villages, albeit with concentration of population on small area.

The following military cases occurred on the Plain during the weeks ending—

Oct. 24th.	Oct. 31st.	Nov. 7th.	Nov. 14th.	Nov. 21st.	Nov. 28th.	Dec. 5th.	Dec. 12th.	Dec. 19th.	Dec. 26th.	Jan. 2nd, 1915.
1	2	1	1	2	2	—	2	4	10	3

The disease was thus definitely established among the troops on the Plain by the end of the year 1914.

It was early seen that prompt action was necessary. At the request of the local authority the late Dr. Ralph Johnstone, Medical Inspector of the Local Government Board, was sent to Salisbury to advise in regard to administrative measures.

The Corporation of Salisbury established, under the direction of Dr. Penfold, of the Lister Institute, London, a bacteriological laboratory for the confirmation and diagnosis of cases and for the detection of carriers of the meningococcus. Warning notices were issued to every house in the city, and the inhabitants were advised to submit to inoculation with a vaccine prepared from killed cultures of the local strain of the meningococcus. A large number of persons availed themselves of the facilities offered. The medical officer of health, Dr. E. T. Fison, M.D. (Cantab.), D.P.H., who strongly advocated this protective vaccination, states that 3,149 persons were gratuitously inoculated by the officers of the Corporation. As this vaccine was supplied

to the medical practitioners of the district and largely made use of by them; Dr. Fison estimates that at least 3,500 persons received protective vaccination in the city.

This is the first instance in England in which an attempt was made to render a population immune to epidemic cerebro-spinal fever through protective inoculation, and though only about 31 per cent. of the census population were inoculated, special attempts were made to secure the inoculation of all contacts. In this way it is conceivable that the bulk of those who were especially exposed to infection were dealt with. The numbers are too small to afford a basis for deduction as to the advantages gained from the procedure adopted. Dr. Fison, however, has put on record that (1) no definite illness, either local or general, beyond normal reaction, resulted from the inoculation, and not a single case of sepsis occurred; (2) no inoculated person contracted the disease, a special point was made of inoculating all contacts; (3) in two instances all the junior members of the family had been inoculated except the one attacked; in another the father was the patient, and his children, inoculated previous to his attack, were not affected; and in one instance an uninoculated child of a family of six, two of whom had been previously inoculated, was attacked.

The cases of cerebro-spinal fever which occurred in the city were received for treatment into "The Infirmary," which in addition received cases from the surrounding districts and from so far away as Shaftesbury, in Dorsetshire.

The outbreak at *Salisbury** commenced on the 15th December, 1914, with the case of a hospital nurse at the Salisbury Infirmary. There were no cases at that time known to exist in the infirmary or in the City of Salisbury. But it was reported after the nurse's death, which occurred in 24 hours after the onset of the disease, that she was frequently in the company of a young officer of the Canadian Expeditionary Force, to whom she was said to be engaged to be married, and after many inquiries this officer was visited and a swab was taken from his throat. The cultures showed infection of his throat with the meningococcus. In the circumstances, and lacking any other known source of infection, it does not seem unreasonable to suppose that the earliest known of the cases that occurred in the outbreak in this epidemic had its origin from this officer.

The second case in Salisbury was a female child aged 5½, who lived in an inn which was frequented by Canadian soldiers. She was attacked on 30th December.

The case in the Pewsey Rural District† was a boy, aged five, who lived at Netheravon, and the only probable source of infection that could be found was that he spent his days playing with the Canadians in their camp. This child was attacked by the disease on 23rd December, and died the day after onset of the illness. He lived at an inn that was much frequented by Canadian soldiers

* My late colleague, Dr. Ralph Johnstone, was in close touch with this outbreak. To his notes and to information supplied to me by Dr. Fison, Medical Officer of Health of the city, I am indebted for the details of this outbreak.

† This case was removed to hospital in the City of Salisbury, when it was notified to the Medical Officer of Health, and thus it appears among the number of cases of cerebro-spinal fever notified in the City.

The following table shows the number of civilian cases of cerebro-spinal fever which occurred in the County of Wilts from the beginning of the year 1915 until the week ending 3rd July:—

Week ending	Wiltshire.	Salisbury City.	Urban districts.	Rural districts.
1915.				
9 January ...	3	3	—	—
16 ,, ...	3	3	—	—
23 ,, ...	1	1	—	—
30 ,, ...	4	1	—	3
6 February ..	3	2	—	1
13 ,, ...	13	6	—	7
20 ,, ...	10	5	3	2
27 ,, ...	9	4	2	3
6 March ...	4	—	—	4
13 ,, ...	2	1	—	1
20 ,, ...	—	—	—	—
27 ,, ...	9	2	1	6
3 April ...	5	1	—	4
10 ,, ...	6	3	3	—
17 ,, ...	4	4	—	—
24 ,, ...	3	1	1	1
1 May ...	3	—	—	3
8 ,, ...	3	—	1	2
15 ,, ...	—	—	—	—
22 ,, ...	—	—	—	—
29 ,, ...	1	—	—	1
5 June ...	1	—	—	1
12 ,, ...	—	—	—	—
19 ,, ...	1	1	—	—
26 ,, ...	1	1	—	—
3 July ...	1	1	—	—
Total ...	90	40	11	39

Among the cases that occurred in Salisbury City was that of a young woman, aged 27, who was employed at a shop in the town. She was attacked on 16th January and died on 10th February. She was engaged to be married to a Canadian soldier, A. R., who had been ill in her house for a week with "influenza," and who had left prior to the illness of the young woman.

On 25th January her mother, aged 55, was attacked and she died on 3rd April.

A. R. had gone to the Tisbury Rural District, where he fell sick on 24th January. He died on 29th January.

There were two other inmates of this house at Salisbury when A. R. was ill with influenza, viz., the grandfather and a soldier of the A.S.C. Both remained well. The throat of the soldier was swabbed on more than one occasion with negative result.

A. R. was a nephew of a shopkeeper, R., in Tisbury, and was taken ill in his house. As soon as he was attacked the entire family were inoculated with protective serum at Salisbury. One of the elder children in the house was found to have a micro-organism

in the naso-pharynx which was said to be "suspiciously like" the meningococcus. She helped to nurse her cousin A. R. when he first became ill on 24th January and before his removal to hospital on 26th January.

Also at Tisbury a young woman, L., was attacked on 6th February. The source of her infection is uncertain. Her brother was an apprentice to R., but it is said he only worked in the yard, and he did not live in the same house as his sister. Soldiers from the neighbouring Codford Camp were billeted in the house where L. resided.

In Salisbury two boys, twins, aged 3 years, were attacked on the same day, 3rd February; both died. In this house the father of the patients, two of his other sons, and two male lodgers worked at Codford Camp.

Devizes Rural District.—Two Canadian soldiers who were billeted in this district were attacked respectively in the weeks ending 9th January and 6th February. No other cases were notified until the week ending 3rd April, when a married woman, aged 44, fell ill; she died within 36 hours of attack. No relationship between this and the two previous cases, nor with soldiers, was traced. Subsequently, in April, two further cases were notified in an isolated cottage $1\frac{1}{2}$ miles from Lavington in the Devizes Rural District. They were sisters, aged seven and two and a half, respectively. The elder had been ill for some weeks and the younger for two weeks before notification. The elder died on 8th May, the younger recovered. No connection between these and those previously attacked, nor with the military, could be traced.

Apart from the Salisbury City cases, others appeared in different parts of the county, and in regard to each of these cases relationship to the military was found to exist, *i.e.* the sufferers had either worked in military camps, or had family relations among soldiers, or soldiers were billeted in the house. It was not until the week ending 20th February that a case was notified concerning which previous contact with troops could not be ascertained.

In the *Warminster Rural District*, in the week ending 20th February, a man and his wife, who kept a small shop frequented by soldiers, were both attacked; and a woman, aged 46, who lived at a farm, was attacked on 22nd March, and on the following day, 23rd March, her daughter, aged 18, fell ill with the disease. The source of infection of these cases was not traced.

In the *Tisbury Rural District* three children, a girl aged eight, and two boys aged eight and nine, belonging to three separate families but all attending the same school, were attacked. The date of onset of the disease in each case is given as 22nd March. The fathers of two of these children worked at Fovant Camp.

Berkshire.

Peculiar interest centres in the *County Borough of Reading* (population, 1911—87,693). A considerable number of troops were billeted in the town and some 20 cases of cerebro-spinal fever occurred among them. The first military case was attacked on 7th February, the second on 9th March, and three others fell ill during the month.

The first civilian case, a boy aged 13, was attacked on 14th January. No history of infection was ascertained, and no soldiers were billeted in his house. The second civilian case was that of a woman, aged 32, who was attacked on 26th February. She was the housekeeper of an hotel.

The Corporation and their officers, energetically supported by the military authorities, dealt promptly with each case. The sick were isolated in hospitals, the diagnosis confirmed by bacteriological examination of cerebro-spinal fluid, and contacts dealt with. Nevertheless, cases among the civilian and the military population continued to occur throughout the six months' period under review.

These cases were carefully inquired into by Dr. Wilkinson, Medical Inspector of the Local Government Board; and appended is a list of the civilian cases with notes taken by him.

Notified Cases of Cerebro-spinal Meningitis in the County Borough of Reading—Civilian cases.

No. of Case and Date. 1915.	Sex.	Age.	Result.	Spinal Fluid + = Meningococcus present.	Contacts with dates of examination and results. + = Positive. — = Negative. Only + contacts re-examined.	Remarks.
1. Jan. 20 ...	M	13	Recovered... ...	+	4—Jan. 25, 1 + 2 re-examined Mar. 16 —	No history of infection ; no billets in house.
2. Mar. 9 ...	F	32	Died Mar. 9 ...	+	5—Mar. 14, 1+ re-examined Mar. 24 —	Housekeeper of an hotel.
3. Mar. 13 ...	F	12	Died April 1 ...	+	8—Mar. 16, 2 + re-examined May 6, both + 2 + re-examined Jan. 9, both —	Dirty house, occupants verminous. Patient's brother, æt. 10, died March 10 " Pneumonia ; heart failure." Patient had been collecting broken bread from billets ; no billets in house. At school on March 10 ; delirious March 11. Sister of M No. 32.
4. Mar. 21 ...	F	8	Died Mar. 23 ...	+	6—Mar. 24, 2 + re-examined May 6, both —	Patient collected food from billets ; dirty house, occupants verminous.
5. Mar. 22 ...	F	8 mos.	Died Mar. 23 ...	+	5—Mar. 23, 1 + re-examined June 16 —	Patient had had cold with convulsions ever since Christmas ; good house, no billets.
6. Mar. 22 ...	F	25	Died May 21 ...	+	6—Mar. 24. All —	Patient attacked March 16. Her husband in 25 Co. City of London Cyclists came home from Military hospital, London, March 1—15 ; had had ? influenza ; returned to Hospital, Cambridge, March 15. Patient is sister of F No. 38.
7. Mar. 23 ...	M.	10	Recovered ...	+	10—Mar. 24, 1 + re-examined May 3 + 1 + re-examined June 7 —	Patient's father in No. 346 Co. A.S.C. Motor Transport, No. 2 Camp, Sling Plantation Camp, Bulford ; came home March 19—22. Patient attacked March 21 ; thought to have had cold with pain in head and stiff neck. Father watched for a week. Dirty overcrowded house.
8. Mar. 23 ...	M	1	Died Mar. 26 ...	+	5—Mar. 25. All —	Father a clerk at Yeomanry House (H.Q., Berks. Yeomanry).
9. Mar. 24 ...	M	39	Died Mar. 29 ...	+	6—Mar. 29. All —	Patient worked in G.W.R. fitters' shop. First thought to have enteric fever. Widal +
10. Mar. 26 ...	F	8	Recovered... ...	+	6—Mar. 26, 2 + re-examined May 3, both + 2 + re-examined June 1, both —	No history of infection ; no billets in house or neighbourhood.

No. of Case and Date. 1915.	Sex.	Age.	Result.	Spinal Fluid + = Meningococcus present.	Contacts with dates of examination and results. + = Positive. − = Negative. Only + contacts re-examined.	Remarks.
11. Mar. 28 ...	F	43	Died April 16 ...	+	2—Mar. 29. Both −	Had been at picture palace three times in week previous to attack ? 1 contact a soldier.
12. Mar. 28 ...	M	2	Recovered... ...	+	6—Mar. 31. All −	A fitter at P's Works lodged with family, one member of which, Private S., was in 8 R. Berks, in which several cases of C.S.F. Private S. watched by Military M.O. ?
13. Mar. 31 ...	M	21	Died April 2 ...	+	7—April 6, 1 + re-examined April 13 −	Patient worked in fitters' shop G.W.R.; no relations with soldiers; house dirty.
14. April 2 ...	F	32	Recovered... ...	+	4—April 7. All −	—
15. April 2 ...	F	26	Recovered... ...	+	3—April 7. All −	Does private nursing; had influenza for some time.
16. April 2 ...	M	46	Died April 3 ...	+	10—April 8, 2 + re-examined April 30 1 + 1 + re-examined May 3 + 1 + re-examined May 18 + 1 + re-examined June 9 −	Patient worked in a brewery; house very dirty; son in R.H.A., but he did not come home until after his father's death.
17. April 6 ...	M	15	—	—	6—April 10. All −	Patient a cabinet-maker at a firm in Reading. His brother came home from Sling Camp, Bulford, on March 28; returned March 29.
18. April 8 ...	M	13	Died April 11 ...	+	7—April 10. 1 + re-examined May 3 + 1 + re-examined June 4 −	Patient a newsboy; quite well evening of April 7; taken suddenly ill 5 a.m. April 8 fits.
19. April 14 ..	M	9	Recovered... ...	+	12—April 17. 3 + re-examined May 8. All −	No history of infection; father a coalheaver on S.E.R.; overcrowded house.
20. April 17 ...	F	8	—	+		Patient a negative contact of her brother No. 19.
21. April 17 ...	M	10	—	+	7—April 19. 2 + ? not re-examined.	No history of infection. No billets in houses. Patient first notified as enteric fever.
22. April 21 ...	M	35	Died April 21 ...	+	5—April 28. 1 + re-examined June 4 −	Patient a coach painter; went to Henley April 18 to see his brother in the R.E. from Portslade Camp; returned April 19, and taken ill that day.
23. April 22 ...	F	30	Recovered... ...	+	2—April 24. Both −	Patient almost confined to house; two soldiers billeted in house; removed to Oxford.
24. April 28 ...	M	17	Recovered... ...	+	*32—April 29. 1 + †3—April 30. All −	Patient a clerk at P's Works. *Workmen at P's Works. †At patient's house.
25. May 1 ...	F	39	Recovered... ...	+	6—May 4. 2 + re-examined June 4. Both −	Patient's husband jobbing gardener. Her brother in 9th R. Berks came to see her from Portsmouth 10—14 days before she was taken ill; now at Bassingham Camp, Wareham, Dorset.

No. of Case and Date. 1915.	Sex.	Age.	Result.	Spinal Fluid + = Meningococcus present.	Contacts with dates of examination and results. + = Positive. − = Negative. Only + contacts re-examined.	Remarks.
26. May 3 ...	M	45	Recovered... ...	+	4—May 4. 1 + not re-examined.	Patient a guard on G.W.R. No known relatives with troops. The + contact left for Ringwood. M.O.H., Bournemouth, informed.
27. May 7 ...	M	52	Recovered... ...	+	7—May 8. 1 + re-examined June 4 −	Patient biscuit maker at H. & P. Went to house of No. 22, where he died.
28. May 10 ...	M	45	Recovered... ...	+	3—May 12. All −	No history except that he had influenza 10 days previously; no billets in house.
29. May 12 ...	F	20	—	−	5—May 14. All −	Patient a charwoman; was at picture palace two days before attack.
30. May 17 ...	F	47	—	+	Only 1 contact; semi-invalid mother not examined.	Patient an outworker of laundry; went out very little; no relations with soldiers.
31. May 18 ...	F	8	—	+	7—May 19. 1 + ? re-examined.	No history of infection.
32. May 18 ...	M	2	Died May 20 ...	+	——	Patient a negative contact of F No. 3. Had been ill for 11 weeks; had fits on May 12, 13 and 15.
33. May 20 ...	F	5	Died May 10 ? ...	+	3—May 23. 1 + not re-examined.	No history of infection.
34. May 27 ...	F	53	Recovered... ...	+	1—May 27. −	Patient works at H. & P.; lives on the river, also works at Messrs. H's.
35. May 29 ...	F	27	—	+	3—May 29. All −	Patient had lived at Caversham until May 27.
36. June 7 ...	F	16	—	+	4—June 9. All −	Patient was taken ill the same day that her brother came to see her; he was in No. 1 Military Hospital, Reading, and had been invalided from France.
37. June 7 ...	M	15	—	+	6—June 7. All −	Patient works at H. & P.'s; taken ill in train suddenly May 13.
38. June 12 ...	F	21	—	+	2—June 15. Both −	Patient is a nurse at Wallingford Union Infirmary; is a sister of F No. 6. Had come to see her sister, but the latter died before she arrived; had also been home on June 11th, but was ill on 9th.
39. June 21 ...	M	39	—	+	3—June 23. All −	Patient works at H. & P.'s; no relations with soldiers; dirty house.
40. June 22 ...	F	35	—	+	2—June 28. Both −	No history of infection.
41. June 26 ...	M	12	—	+	5—June 29. All −	No history.
42. June 28 ...	F	27	—	+	Contacts not examined.	Patient a domestic servant in good class house; went out very little; no relations with soldiers.
43. June 30 ...	M	21	—	+	9—July 1. All −	Went to picture palace a few days before attack; had influenza and was admitted to R. Berks Hospital for supposed pleurisy; symptoms of meningitis developed there.

Easthampstead Rural District.—A woman, aged 57, had been at work in the laundry at a college sanatorium where there was an outbreak of influenza. She was attacked on a day antecedent to the 19th February. She died on the 23rd of that month. The certified cause of death was "influenza, meningitis." When she became ill her daughter came, on the 19th February, from Malmesbury, in Wiltshire, to nurse her mother, bringing her own baby aged 12 months. This child was taken ill on the 24th February, and died on the 27th February from cerebro-spinal fever. The diagnosis was verified by bacteriological examination of the cerebro-spinal fluid. Two boys, aged 13, were notified on the 7th March suffering from cerebro-spinal fever at the college where this woman worked. One attacked on the 6th March died on the 7th, and this case was verified by bacteriological examination. In this district a girl aged five years and a man aged 29, and a boy aged 4 in the Hungerford Rural District, and a girl aged 6 in the Wallingford Rural District, all died the day after the onset of illness. In the Newbury Urban District a man aged 63, was attacked on the 12th April, and his illness proved fatal. He had been visited by his two sons, one on the 1st April and one on the 1st-3rd April. The former came from one of His Majesty's ships, in which no case of cerebro-spinal fever occurred. The latter was one of a guard on a ship for prisoners of war. One of the guard in this ship had been attacked on the 6th March, and later, on the 20th April, a prisoner was attacked by cerebro-spinal fever.

Gloucestershire.

City of Bristol.—Population at the Census, 1911, 357,048.—Cerebro-spinal fever is by no means a new disease in the City of Bristol, and the matter has been subject to close scrutiny by the Medical Officer of Health, Dr. D. S. Davies, and his staff.

In the year 1914, 32 cases of the disease occurred, and of these 27 were received into the Isolation Hospital for treatment. The age, sex and fatality of these cases is shown in the table on p. 87.

The larger number of the patients were children, but six out of the 32 cases were over 20 years of age. The fatality was 65·6 per cent.

In 1915 up to 30th June, 90 notifications of persons notified as suffering from cerebro-spinal fever were received by the sanitary authority. Of these 75 were civil cases, including two men engaged as civil grooms at the Military Remount Depôt, Shirehampton, and 20 of these notified cases proved not to be cerebro-spinal fever on subsequent inquiry. The military cases numbered 15, but in two of these cases the diagnosis was revised later.*

The age, sex and fatality of the 55 civil cases is shown in the table below.

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* In two of the civil cases the onset of the disease occurred in the year 1914, in one instance as far back as 13th October.

Of the 55 cases 14 were over 20 years of age and 58·2 per cent. were fatal.

——	0—1 year.				1—5 years.				5—10 years.				10—15 years.			
Year.	M		F		M		F		M		F		M		F	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
1914	–	–	1	1	9	7	6	5	4	2	2	2	2	1	–	–
1915	2	2	2	2	10	7	3	2	5	2	3	1	2	2	6	2

——	15—20 years.				20—30 years.				30 years and upwards				Total.			
Year.	M		F		M		F		M		F		M		F	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
1914	2	–	–	–	1	–	1	1	2	–	2	2	20	10	12	11
1915	3	2	5	1	4	2	3	2	4	2	3	3	30	19	25	13

Excluding the cases whose onset was prior to 1915 and the two cases which were really not Bristol cases, but which had occurred outside the city area and had been admitted to hospitals within the city for treatment, and including all the military cases, excepting one whose onset of disease took place abroad, the cases of cerebro-spinal fever occurred on the following dates:—

Date.	Cases.	Remarks.
1915.		
January 1	1	——
,, 15	1	——
,, 23	1	——
,, 25	1	——
,, 27	1	——
,, 28	1	——
February 3	1	——
,, 5	1	——
,, 13	1	Civilian groom employed at the Remount Depôt, Shirehampton.
,, 15	1	——

Date.	Cases.	Remarks.
1915.		
February 17	1	——
,, 20	1	Military case.—Horsfield Barracks.
,, 21	3	——
,, 22	1	——
,, 23	1	——
,, 24	1	——
,, 25	1	——
,, 26	2	——
,, 27	1	——
,, 28	1	Military case.—Fairfax Street Barracks.
March 2	1	——
,, 5	1	——
,, 9	2	——
,, 14	1	Military. From an hotel in Clifton.
,, 15	2	——
,, 16	1	——
,, 18	2	——
,, 27	1	——
,, 31	1	Civilian groom employed at the Remount Depôt, Shirehampton.
April 2	1	——
,, 4	1	——
,, 8	2	Military cases; one from Remount Depôt, Shirehampton.
,, 13	1	——
,, 16	2	Military cases. One from Avonmouth; the other arrived ill from Broomfield in Essex.
,, 20	1	——
,, 21	2	——
,, 22	1	Military case, Remount Depot, Shirehampton.
,, 23	1	Military case from Avonmouth. A contact of the case of 16 April.
,, 24	1	——
,, 29	1	Military case. An officer stationed at Avonmouth.
,, 30	1	Military case, Shirehampton.
May 1	1	——
,, 7	2	——
,, 12	1	——
,, 13	1	——
,, 15	2	——
,, 23	2	——
,, 24	1	——
,, 25	1	Military case. Taken ill when coming from Bulford to Brislington.
,, 26	1	——
June 18	1	——

Bristol City has been the centre of considerable military activity. Some years back the boundaries of the City were extended to take in Avonmouth, where there are docks opening on the Bristol Channel. In this neighbourhood is the large military depôt of the Army Service Corps and Mechanical Transport and the Remount Depôt at Shirehampton. When it is considered that cerebro-spinal fever infection was present within the City area, as shown by the notifications of the disease during the year 1914, the peculiar liability of the City in 1915 to the introduction of infectious disease owing to the constant passage of large numbers of

troops and influx of camp followers, and the added traffic of a large and busy port, it seems rather remarkable that Bristol has not suffered from a much more severe visitation of cerebro-spinal fever. Cases of the disease have been scattered all over the city, the only marked grouping being about Avonmouth and Shirehampton. It is to be borne in mind that Bristol is well equipped with hospitals. Some of the cerebro-spinal fever cases have been treated in the Childrens' Hospital (in an isolation building), some in the Bristol Infirmary, others at Stapleton Infirmary and Novers Hill Hospital, and the remainder at the Ham Green Isolation Hospital. In addition to his duties as medical officer of health, Dr. D. S. Davies, with the rank of Lieut.-Colonel, R.A.M.C., acts as specialist sanitary officer for the district, and is in intimate relation with all local military matters. Early in the year he issued to medical practitioners in the city a circular of warning and of information in regard to the disease. He arranged for the health visitor in the city and the district nurse at Avonmouth and at Shirehampton to visit contacts at frequent intervals, to advise as to precautions on the lines of the circular referred to, and also to ensure that the contacts made use of sprays. Swabs were taken from some of the civil cases. Contacts were advised to begin the spraying treatment without waiting for any swabbing to be done first. The swabs were examined by Professor Walker Hall, of the Bristol University, who also acted as bacteriologist for the troops.

A boy aged 7 was attacked on 20th April. He was removed to the Bristol General Hospital. His sister, aged 5 years, became ill on 24th April, and "spots" developed on her body the following day. She got better and was not then removed to hospital. However, she again became ill, and was admitted to the General Hospital on 5th May, where she died on 10th May. In this case the meningococcus was found. When the boy was attacked the contacts were placed under spray treatment of the naso-pharynx, under the superintendence of a nurse.

A child aged 15 months, attacked on 15th May, became covered with "spots" on 16th and died on 17th May. On post-mortem examination the diagnosis of cerebro-spinal fever was made. The father of the patient was a soldier, who came home from Dartford on 27th April for three days. At that time three cases of cerebro-spinal fever had occurred among the troops at Dartford, viz., on the 22nd and 26th February and the 8th March. The father had been transferred to Taunton before his child became ill, and he returned home when his child was attacked. His naso-pharynx was swabbed on two successive occasions with negative result.

A young woman aged 18, attacked on 13th May, was in the habit of associating with soldiers, but nothing more definite as to her source of infection was discovered.

The husband of the woman (aged 37) attacked on 27th March was employed at the Remount Depôt, Shirehampton.

A man, aged 28, fell ill in September, 1914; the diagnosis of cerebro-spinal fever received bacteriological confirmation. He was again attacked by the disease on 27th February and died on 2nd March.

The woman (aged 47) attacked on 24th February and the girl (aged 15) who fell ill on 26th February lived at houses which were visited for meals by men employed at the Remount Depôt, Shirehampton.

The girl aged 12 who was attacked on 23rd February was the daughter of an officer who was stationed at the White City, London. He was home on leave from 3rd–13th February, but at that time no cases of cerebro-spinal fever were known to have occurred at the White City.

On 17th February a baby, aged five months, was attacked. His brother was a soldier who had been home on leave from 13th-15th February from Shalford, near Guildford.

The case attacked on 5th February was a girl aged 15. Her brother, who belonged to the Naval Brigade stationed at the Crystal Palace, came home on leave on 30th January and returned on 31st January. He had a cold at the time of his visit home. Prior to this visit cases of cerebro-spinal fever had occurred among the Naval Brigade at the Crystal Palace. Assuming that the brother was a carrier of infection, the incubation in this case would be between five and seven days.

The father of the patient aged two years and nine months who was attacked on 25th January was employed as a labourer unloading trains, etc., with the A.S.C. at Bulford. He was home on leave 4th-7th December and 16th-18th January. By the latter date cases of cerebro-spinal fever had occurred at Bulford among the troops and a soldier in the A.S.C. had been attacked.

A soldier from the 6th Gloucester Regiment came home to Stokes Cross, in the city area, from Danbury, in the Chelmsford Rural District, on leave from 15th until 20th January, and returned quite well. On 21st January another soldier, Sapper H., belonging to the No. 2 Field Company, South Midland, Royal Engineers, came home to the same house from Springfield, also in the Chelmsford Rural District, and remained until 26th January, and left in good health. One case of cerebro-spinal fever occurred on 26th January among troops in the Chelmsford Rural District, but not among the units to which either of these two men belonged. Two soldiers of the 5th Gloucester Regiment had been attacked in Chelmsford Urban District on 21st and 22nd January, dying on 24th and 25th January.

Sapper H. had been billeted in the same house as another soldier who at the time Sapper H. left for Bristol was considered to be suffering from influenza, but who in the course of a few days rapidly developed cerebro-spinal fever. A girl, aged 11, in Sapper H.'s house sickened on 28th January, having a definite attack of shivering with acute symptoms of meningitis. On the assumption that Sapper H. had brought the infection to the house, the incubation period would be between two and seven days.

Towards the end of January an engineer, aged 24, who was employed on a vessel used as a military transport, arrived at Bristol ill, and subsequently died of cerebro-spinal fever.

Hampshire.

County Borough of Portsmouth.—No case of cerebro-spinal fever was notified in Portsmouth during the year 1914, but the medical officer of health, A. Mearns Fraser, M.D., D.P.H., reports that an inquest was held on 16th September on a female child aged 5 months who had died on 11th September. The jury returned a verdict of death from cerebro-spinal meningitis, in accordance with the post-mortem appearances found by the medical man in attendance. There was, however, no bacteriological confirmation of this diagnosis.

In 1915 at Portsmouth the first cases occurred among the naval and military population. A private at the Royal Marine Artillery Barracks, Eastney, was attacked on 15th January, and a soldier quartered in the Hilsea Huts was taken ill with the disease on 19th January. Another soldier of a different military unit, who was billeted in the Old Brewery, High Street, was attacked on 24th January.

The first notification of a civil case, though possibly he was not the first civilian to be attacked, was that of a child aged 4 years. The child was apparently quite well on the evening of 10th February, and he died at 10 p.m. on 11th February. His father was a bombardier in the Royal Marine Artillery who lived out of barracks and in a neighbouring house. The boy attended the school at the R.M.A. Barracks at Eastney. Following the first case of 15th January, other cases of cerebro-spinal fever had occurred among the recruits at these barracks prior to the attack of the child. It is said that the recruits used the same schoolroom as the children but at different hours. Interest centres in this outbreak as being associated with the Canadian soldiers on Salisbury Plain. On 9th January the Canadians sent a team to play a football match against the Royal Marine Artillery, and the visitors stayed this night in the barracks. None of the R.M.A. team subsequently developed cerebro-spinal fever, but at that time there were cases of the disease among the Canadians on the Plain.

On the 22nd February a young woman aged 23 was taken seriously ill with marked symptoms of cerebro-spinal fever. It was ascertained that this patient was living at home and that her brother, a private in the Motor Transport Army Service Corps, came home from Milldam Barracks ill with influenza. The whole family then suffered attack by influenza. In the case of the young woman the onset was on 6th February, and as she recovered slowly she went on 20th February to stay at another house, where she developed symptoms of cerebro-spinal fever on 22nd February, as stated above.

On 17th February a boy, aged 10 years, was notified as suffering from cerebro-spinal fever. At that time he was a patient in the Union Infirmary. The onset of his disease began on 1st February, and he was notified on 11th February as suffering from enteric fever; the diagnosis was subsequently corrected. He did not attend the Eastney Barracks School, and no connection with any other case of cerebro-spinal fever was traced.

Following the cases mentioned above, cases continued to occur in Portsmouth among the civil population. Some of these cases

were not promptly notified, but inquiry by Dr. Mearns Fraser, the Medical Officer of Health, showed the dates of onset of the disease to be as follows:—

Week ending	No. of cases.	Week ending	No. of cases.
13 February, 1915	2	1 May, 1915	2
20 ,, ...	6	8 ,, ...	0
27 ,, ...	5	15 ,, ...	1
6 March	12	22 ,;	0
13 ,, ...	6	29 ,, ...	0
20 ,, ...	5	5 June	0
27 ,, ...	5	12 ,, ...	0
3 April	3	19 ,, ...	1
10 ,, ...	2		
17 ,, ...	4		57
24 ,, ...	3		

Of these cases one was a boy, aged five and a half years, who attended the Royal Marine Artillery School at Eastney Barracks, who was attacked on 16th February; on 17th February his sister, aged four years, was attacked.

There is also a small group of cases, the first of which was that of a young man, aged 17, who was employed in the outfitting department of a pawnshop; it is said he had nothing to do with the pledge department. The onset of disease was on 19th February, and the patient died on 22nd February. A girl living in this pawnshop was employed as a day servant at another house, where she attended for the last time on 22nd February. On the 25th February a small child aged one year and eight months, and on 28th February a little girl aged nine were attacked in this house.

In some of these civil cases there was association with naval or military cases, but no definite source of infection was traced. Thus a girl aged seven and a boy aged six and a half, belonging to different families, attended the Sunday-school at the Royal Marine Artillery Sunday-school at Eastney Barracks. A young man, aged 18, was a workman in H.M. Dockyard; another, aged 28, was the landlord of an inn frequented by soldiers. A boy, aged eight, was the son of a non-commissioned officer at the R.M.A. Barracks, Eastney, and this man had suffered from influenza with severe headache a fortnight previous to the boy's attack by cerebro-spinal fever. Another child, aged eight months, was the son of a petty officer, and another child, aged one year and eight months, was the daughter of a seaman stationed at the Royal Naval Barracks, Portsmouth. A woman, aged 24, was the wife of a sailor stationed at Portsmouth.

Winchester and its Neighbourhood.—This outbreak began early in January, and it involved not only persons resident in the city, but the military billeted therein or in barracks in the town, and also persons living in the neighbourhood of the city.

The first case was notified on 25th January, but subsequent inquiry by Dr. Milburn, the Medical Officer of Health, disclosed the fact that the onset of the disease in this case occurred as early

as 7th January; it was not notified until more than a fortnight after admission to the County Hospital.

The course of the outbreak is shown, week by week, in the following table:—

Week ending.	No. of cases.	Week ending.	No. of cases.
9 January, 1915	1	6 March, 1915	3
16 ,, ...	0	13 ,, ...	3
23 ,, ...	2	20 ,, ...	0
30 ,, ...	0	27 ,, ...	1
6 February	4	3 April	0
13 ,, ...	1	10 ,, ...	2
20 ,, ...	4	17 ,, ...	1
27 ,, ...	3		

Of these, five cases were military and five were cases which occurred outside the city, but which were admitted for treatment to hospitals in the city.

Two further cases were notified in Winchester in the first six months of the year, viz., one each in the weeks ending 22nd May and 19th June.

There was no lack of hospital accommodation, and some of the cases were admitted to the County General Hospital and the V.A.D. Hospital before being diagnosed; but these hospitals very soon refused to take cases of cerebro-spinal fever. There was never, however, any shortage of room for cases. The later cases were treated either in the Victoria Isolation Hospital, belonging to the Corporation, under the care of Dr. Milburn, the Medical Officer of Health, or by the military authorities in their own hospitals.

The late Dr. Ralph Johnstone, Medical Inspector of the Local Government Board*, was sent by the Board to inquire into the circumstances of the outbreak and to afford such assistance to the City Corporation as he was able to afford. He found there was no competent bacteriologist available to verify the diagnosis or to take swabs from the naso-pharynx, or to examine these swabs with the object of detecting carriers.

The City Town Council provided quarters for a laboratory which was promptly fitted up, and the Board as an aid in emergency sent Dr. Griffith of their pathological staff to make the necessary bacteriological examinations. Dr. Griffith arrived at Winchester on 2nd February with the appliances and apparatus necessary to commence immediate work. He carried on the bacteriological work in Winchester until the 26th February, when, unfortunately, he had to be recalled to duty in London on account of press of work at headquarters. During his short stay at Winchester Dr. Griffith made examination of 10 specimens of cerebro-spinal fluid, and examined 90 swabs from contacts, five of these cases proving carriers of the meningococcus. He also assisted in the administration of serum in cases where intrathecal injections were made.

* This account of the occurrence of cerebro-spinal fever is written mainly from Dr. Johnstone's notes.

This co-operation by the Board's medical staff was appreciated by the inhabitants and the medical profession in and around Winchester.

On 11th March the Medical Officer of Health of the County issued a circular letter to the medical practitioners of the county, informing them that bacteriological examination of cerebro-spinal fever would be undertaken in the County Laboratory.

The population of the City of Winchester was 23,378 at the Census in 1911, and it will be realised that the outbreak of cerebro-spinal fever was not a severe incidence on the population. It would be useless, however, to make any attempt to draw reliable conclusions from the figures available. There was during the epidemic outbreak a military population in camps and billets near and in Winchester which was always shifting, and for which no reliable information could be had. It was variously estimated at between 5,000 and 10,000.

The first case which occurred was that of a girl aged 14, who was attacked on 7th January. She lived in a public-house frequented by Canadian soldiers. It was found that the mother of the second case, a boy aged 12, who was attacked on 21st January and died on 4th February, had visited the first case before and after her admission to hospital, and prior to the diagnosis of cerebro-spinal fever being arrived at. This woman was found by Dr. Griffith to be a carrier of the meningococcus. The next two cases were military ones. The first of these, P., was a soldier who had served in India, and who had suffered from malaria, which masked the early symptoms of cerebro-spinal fever. He was on duty with a guard on the railway in company with some Canadians, and he was attacked on 23rd January; he recovered. The second military case, Q., was that of a bandboy, aged 18, who was picked up in a comatose condition lying on the roadside on a wet and stormy night (31st January) and carried to the Red Cross Hospital. He died there during the night, and an inquest was held at which the police surgeon, who made a post-mortem examination, gave evidence that the deceased met his death from natural causes, with some sort of blood poisoning; a form of food poisoning was in fact suspected. Dr. Milburn, the City Medical Officer of Health, having ascertained that no examination of the meninges had been made and no material taken for bacteriological examination, asked for and was granted permission to make further examination, and he obtained from the cerebro-spinal fluid a gram-negative diplococcus. This decided the diagnosis. Twenty-four of the band were swabbed and two were found to be carriers, one being a bugle teacher, and in this sort of way infection might well be passed on mouth instruments in the course of instruction. Another member of this band was attacked on 25th February; he recovered. During the few hours Q. was at the hospital he was nursed by Nurse S. who, after his death, was swabbed amongst the other contacts and found to be a carrier. She was isolated at the Red Cross Hospital, and there she was guarded carefully by strict rule to avoid spread of infection. A new nurse, A., aged 43, came to the hospital, and, not knowing the regulations which had been made for Nurse S.'s isolation, spent an afternoon in her company, and about ten days afterwards was attacked by the disease and died in two days. The

infection seems to have descended direct through Nurse S. from the soldier Q., though there may have been some other source of infection from other contacts, though all were swabbed who could be discovered. Nurse S. did not develop the disease.

Lancashire.

Liverpool City.—Population (Census, 1911), 746,421. During the year 1914 there occurred in the City 33 cases of cerebro-spinal fever. The patients were all under 20 years of age, and the fatality was high; the age and sex distribution is shown in the following table:—

All ages.		0—1				1—5				5—10				10—15				15—20			
Both sexes.		M.		F.		M.		F.		M.		F.		M.		F.		M.		F.	
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
33	19	5	4	4	2	7	6	2	–	4	1	6	3	4	3	–	–	1	–	–	–

Of these cases 9 occurred in the weeks ending as follows:—5th September, 2 cases; 12th September, 2 cases; 3rd October, 1 case; 10th October, 2 cases; 24th October, 1 case; 28th November, 1 case.* A case occurred in January, 1915 (not notified until 21st May), the patient being a male child aged 7 years.

No further cases occurred until a soldier billeted in Liverpool was attacked on 13th February; no spread of disease was traced to this case. The next civil case occurred on 8th March, the patient being a woman aged 48; no relation of this case to military cases was discovered.

Further cases occurred as follows:—

Date.	Sex.	Age.
1915.		
26 March	Female	7 years.
28 ,, ...	,, ...	27 years.
28 ,, ...	,, ...	3 years.
17 April	,, ...	6 weeks.
17 ,, ...	,, ...	12 years.
26 ,, ...	,, ...	4 years.
28 ,, ...	Male	1 year.
5 May	Female	8 months.
6 ,, ...	,, ...	2 years.
8 ,, ...	,, ...	12 years.
14 ,, ...	,, ...	7 months.
15 ,, ...	,, ...	5 months.
22 ,, ...	,, ...	5 years.
25 ,, ...	,, ...	3 years.
3 June	,, ...	1 year.
10 ,, ...	,, ...	5 months.

* This case (a child aged 4½ months) only came to the notice of the Medical Officer of Health through the death appearing in the death returns. It is shown in the notified returns for the week ending 9th January, 1915.

Two of these cases were children of soldiers, but in one case the father had not seen his child for some months previous to her attack. In the other case the father was home on leave from 4th June to 11th June, and the child was attacked on 10th June. There is no evidence that the father infected the child.

It will be seen that for the first six months of the year 1915 no undue prevalence of cerebro-spinal fever occurred in Liverpool.

Manchester City.—Population (Census, 1911), 714,333.—A case of cerebro-spinal fever was notified in the City during the week ending 5th September, 1914. The next case occurred on 17th December, the patient being a girl aged 13. This case was not notified until after death in January, 1915, and on investigation by the medical officer of health the conclusion arrived at was that death had probably resulted from influenza. In the first six months of the year 1915, the following cases occurred in the City:—

Week ending	No. of cases.	Sex.	Age.
20 March, 1915 ...	1	Female ...	7 years.
10 April	2	Female ...	10 months.
		Male ...	14 months.
17 ,, ...	1	Female ...	7 months.
24 ,, ...	2	Male ...	40 years.
		Female ...	1 year.
1 May	1	Male ...	9 years.
8 ,, ...	1	Male ...	10 months.

The other cases notified were soldiers who had been admitted to hospital in the City for treatment. The City of Manchester had, in fact, few cases of cerebro-spinal fever.

Several points of interest in connection with the prevalence of cerebro-spinal fever in England and Wales can only be dealt with when available data have been collected and examined, and when reason no longer exists for reticence in regard to the distribution of troops in the country.

It has been seen that, in the three years prior to 1915, although the greater number of cases have occurred during the first six months of the year, there has been no marked seasonal curve. In the first six months of the year 1915 there is a pronounced curve; this can be gathered from the total figures shown at the foot of Table III. (Appendix).

The curve begins to rise at the end of January, and makes a steep ascent in February, reaching its highest point in the third week in April, after which it falls steadily till the end of June.

It will be seen from Tables I. and II. (Appendix) that while cerebro-spinal fever was generally distributed throughout the country, no special prevalence of the disease occurred until the end of the year 1914. This would coincide with the seasonal movement of persons on visits to their homes and families and

the customary gatherings frequented by those on holiday, and with the Christmas leave—by no means limited to the actual Christmas week—given to the troops. Several instances occurred in which soldiers leaving the Salisbury Plain and other camps, fell sick with the disease on arriving at their homes; and it is conceivable that others, civilians as well as soldiers, who did not exhibit meningeal symptoms and who were in apparent health, may have been actual carriers of infection and instrumental in the spread of the disease.

Prior to the year 1915, apart from the greater number of cases occurring in thickly populated places, the disease cannot be said to have been specially prevalent in any part of England and Wales.

The general distribution of cerebro-spinal fever throughout England in the three years 1912–1914 is shown in Table I. (Appendix). In these three years one or more cases of the disease have been known to have occurred in each county in England, with the exception of Huntingdonshire, Herefordshire, Lincolnshire (parts of Holland), Rutlandshire, the Isle of Ely and the Isle of Wight; there are no large centres of population in any of these places. In Wales the few cases that occurred were limited almost entirely to the populous parts of Glamorganshire; there is a marked absence of the disease in the remainder of the Principality.

In the first six months of the year 1915 cases appeared in all the counties with the exceptions of Lincolnshire (Kesteven), Rutlandshire, Brecknockshire and Montgomeryshire.

In the period 1912–1914 the industrial centre of Lancashire furnished 13·4 per cent. and London 30·5 per cent. of the total number of cases; but in terms of population London had 12 per cent. less cases than had Lancashire.

If a line be drawn across England from the Wash to the Bristol Channel, it will be seen that of the 2,045 cases shown in Table III. to have occurred in England and Wales during the first six months of the year 1915, 1,656, including London cases, occurred in the counties situated to the south-east of this line. Including London the counties south-east of the line had 81 per cent. of the cases in England and Wales, and excluding the London figures altogether the counties south-east of the line had 75·3 per cent. of the cases in England and Wales.*

In terms of population the "S.E." counties, including London, had over five times as much cerebro-spinal fever as the "N.W." counties had (2,094 : 389); and excluding London altogether the proportion is practically the same (2,098 : 389).

It is common knowledge that for military purposes the greater number of troops would be stationed in the east and south-eastern parts of England, and that comparatively few troops would be quartered in Wales.

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* In the 1911 census the population of the "S.E." counties,
including London = 15,927,211
excluding London = 11,405,526
The population of the "N.W." counties = 20,143,281

It may be inferred that the manifestation of the disease has been in some way associated with the presence of troops in the area specially affected. The number of troops located south-east of the line may have considerably altered the 1911 Census distribution of the population.

At the commencement of the epidemic of cerebro-spinal fever at the end of the year 1914, comparatively few English bacteriologists possessed a practical working knowledge of the diplococcus of Weichselbaum. Lieut.-Colonel Mervyn Gordon has since shown that at least four specimens of the meningococcus were operative in the 1915 outbreak, albeit in widely different amount. It is not known whether the predominant types of meningococcus of this epidemic are identical with the micro-organism causative of cerebro-spinal fever which occurred prior to the period of increased prevalence of the disease at the end of the year 1914, or whether types of this micro-organism, already present and widely distributed throughout the country, have acquired through unrevealed factors an unprecedented virulence and capacity for infection; or whether the prevailing types of the meningococcus are recent importations to this country and operating a non-immune population.

APPENDIX.

TABLE I.—*Showing distribution of cases of Cerebro-spinal Fever in England and Wales.*

Counties. Name.	Counties. Population at Census, 1911.	Total Number of Cases of Cerebro-spinal Fever in Geographical County. 1912	1913	1914	County Boroughs. Population at Census, 1911.	County Boroughs. No. of Cases of Cerebro-spinal Fever. 1912	1913	1914	Boroughs and Urban Districts. Population at Census, 1911.	Boroughs and Urban Districts. No. of Cases of Cerebro-spinal Fever. 1912	1913	1914	Rural Districts. Population at Census, 1911.	Rural Districts. No. of Cases of Cerebro-spinal Fever. 1912	1913	1914
London	4,521,685	102	86	70	—	–	–	–	4,521,685	102	86	70	—	–	–	–
Bedfordshire	194,588	–	–	3	—	–	–	–	116,994	–	–	1	77,594	–	–	2
Berkshire	271,009	2	1	1	87,693	2	–	1	57,512	–	–	–	135,589	–	1	–
Buckinghamshire	219,551	4	–	–	—	–	–	–	79,955	1	–	–	139,596	3	–	–
Cambridgeshire	128,322	–	2	–	—	–	–	–	51,561	–	–	–	76,761	–	2	–
Ely, Isle of	69,752	–	–	–	—	–	–	–	36,608	–	–	–	33,144	–	–	–
Chester	954,779	8	1	7	278,504	4	1	3	493,027	3	–	2	183,248	1	–	2
Cornwall	328,098	3	–	–	—	–	–	–	144,118	2	–	–	183,980	1	–	–
Cumberland	265,746	2	1	–	—	–	–	–	164,812	–	–	–	100,934	2	1	–
Derbyshire	683,964	4	4	–	123,410	2	1	–	287,689	–	–	–	272,324	2	3	–
Devonshire	699,703	6	3	1	242,372	2	–	–	230,918	2	2	–	226,413	2	1	1
Dorsetshire	223,266	–	–	1	—	–	–	–	118,458	–	–	1	104,808	–	–	–
Durham	1,369,860	5	3	4	440,646	1	1	2	528,095	2	–	–	401,119	2	2	2
Essex	1,350,881	6	16	11	289,030	1	2	5	802,896	5	13	5	258,955	–	1	1
Gloucestershire	736,097	8	16	34	407,083	7	16	32	100,419	1	–	1	228,595	–	–	1
Herefordshire	114,269	–	–	–	—	–	–	–	39,867	–	–	–	74,402	–	–	–
Hertfordshire	311,284	–	1	1	—	–	–	–	194,242	–	1	–	117,042	–	–	1
Huntingdonshire	55,577	–	–	–	—	–	–	–	23,652	–	–	–	31,925	–	–	–
Kent	1,045,591	4	5	5	24,626	–	–	1	708,808	4	–	2	312,157	–	5	2
Lancaster	4,767,822	33	31	49	3,029,347	22	21	43	1,498,315	10	9	5	240,170	1	1	1
Leicestershire	476,553	1	1	6	227,222	–	1	2	98,519	–	–	–	150,812	1	–	4
Lincolnshire—																
Parts of Holland	82,849	–	–	–	—	–	–	–	37,233	–	–	–	45,616	–	–	–
Kesteven	111,324	–	1	–	—	–	–	–	43,982	–	1	–	67,342	–	–	–
Lindsey	369,787	2	3	1	131,944	1	–	–	96,120	–	1	1	141,723	1	2	–

Counties.		Total Number of Cases of Cerebro-spinal Fever in Geographical County.			County Boroughs.				Boroughs and Urban Districts.				Rural Districts.			
Name.	Population at Census, 1911.	1912	1913	1914	Population at Census, 1911.	No. of Cases of Cerebro-spinal Fever. 1912	1913	1914	Population at Census, 1911.	No. of Cases of Cerebro-spinal Fever. 1912	1913	1914	Population at Census, 1911.	No. of Cases of Cerebro-spinal Fever. 1912	1913	1914
Middlesex	1,126,465	4	8	8	—	–	–	–	1,078,334	4	8	8	48,131	–	–	–
Norfolk	499,116	–	2	1	177,383	–	1	1	60,885	–	1	–	260,848	–	–	–
Northamptonshire	303,797	2	2	–	90,064	1	–	–	95,496	1	1	–	118,237	–	1	–
Peterboro', Soke of	44,718	1	–	–	—	–	–	–	33,574	–	–	–	11,144	1	–	–
Northumberland	696,893	5	3	3	325,419	4	2	3	269,876	–	1	–	101,590	1	–	–
Nottinghamshire	604,098	3	3	–	259,904	–	2	–	214,878	2	–	–	129,316	1	1	–
Oxfordshire	199,269	2	–	–	53,048	–	–	–	36,317	–	–	–	100,119	2	–	–
Rutlandshire	20,346	–	–	–	—	–	–	–	3,667	–	–	–	16,679	–	–	–
Shropshire	246,307	1	–	1	—	–	–	–	109,673	–	–	1	136,634	1	–	–
Somersetshire...	458,025	3	5	7	69,173	–	–	–	157,356	1	1	3	231,496	2	4	4
Southampton	862,393	6	7	2	428,827	1	3	–	204,341	4	2	2	229,225	1	2	–
Wight, Isle of	88,186	–	–	–	—	–	–	–	57,127	–	–	–	31,059	–	–	–
Staffordshire	1,279,649	5	12	11	609,269	3	4	7	461,338	1	8	3	209,042	1	–	1
Suffolk, East	277,155	4	3	4	73,932	2	–	3	80,953	2	1	–	122,270	–	2	1
,, West	116,905	2	–	5	—	–	–	–	43,855	–	–	5	73,050	2	–	–
Surrey	845,578	4	9	5	169,551	–	–	–	452,788	4	5	1	223,239	–	4	4
Sussex, East	487,070	3	1	4	244,924	1	–	2	115,841	1	–	2	126,305	1	1	–
,, West	176,308	3	1	–	—	–	–	–	83,590	2	1	–	92,718	1	–	–
Warwickshire	1,247,418	6	9	14	946,551	4	8	11	133,678	2	1	2	167,189	–	–	1
Westmorland	63,575	1	2	–	—	–	–	–	26,875	–	–	–	36,700	1	2	–
Wiltshire	286,822	1	6	7	—	–	–	–	125,100	1	–	5	161,722	–	6	2
Worcestershire	526,087	–	2	2	99,061	–	–	1	153,336	–	2	1	135,291	–	–	–
Yorkshire—																
East Riding	515,041	2	1	4	360,273	2	–	4	59,984	–	–	–	94,784	–	1	–
North Riding	419,546	–	–	3	104,767	–	–	–	178,196	–	–	3	136,583	–	–	–
West Riding	3,045,377	15	18	14	1,460,497	10	14	10	1,202,228	5	3	3	382,652	–	1	1

Counties.		Total Number of Cases of Cerebro-spinal Fever in Geographical County.			County Boroughs.				Boroughs and Urban Districts.				Rural Districts.			
Name.	Population at Census, 1911.				Population at Census, 1911.	No. of Cases of Cerebro-spinal Fever.			Population at Census, 1911.	No. of Cases of Cerebro-spinal Fever.			Population at Census, 1911.	No. of Cases of Cerebro-spinal Fever.		
		1912	1913	1914		1912	1913	1914		1912	1913	1914		1912	1913	1914
Wales—																
Anglesey	50,928	–	1	–	—	–	–	–	18,994	–	1	–	31,934	–	–	–
Brecknockshire	59,287	–	–	–	—	–	–	–	17,556	–	–	–	41,731	–	–	–
Cardiganshire	59,879	–	–	–	—	–	–	–	16,324	–	–	–	43,555	–	–	–
Carmarthenshire	160,406	–	1	–	—	–	–	–	65,815	–	–	–	94,591	–	1	–
Carnarvonshire	125,043	–	–	–	—	–	–	–	58,334	–	–	–	66,709	–	–	–
Denbighshire	144,783	–	–	–	—	–	–	–	48,612	–	–	–	96,171	–	–	–
Flintshire	92,705	–	–	–	—	–	–	–	34,864	–	–	–	57,841	–	–	–
Glamorganshire	1,120,910	3	4	4	377,912	3	3	4	537,096	–	1	–	205,902	–	–	–
Merionethshire	45,565	–	–	–	—	–	–	–	20,163	–	–	–	25,402	–	–	–
Monmouthshire	395,719	1	3	7	83,691	–	–	1	269,474	1	3	6	42,554	–	–	–
Montgomeryshire	53,146	–	–	–	—	–	–	–	19,140	–	–	–	34,006	–	–	–
Pembrokeshire	89,960	–	–	–	—	–	–	–	38,779	–	–	–	51,181	–	–	–
Radnorshire	22,590	–	–	–	—	–	–	–	5,806	–	–	–	16,784	–	–	–
Total ...	36,070,492	267	278	300	10,869,972	73	80	136	17,292,964	163	153	133	7,907,556	31	45	31

TABLE II.—*Showing the distribution in England and Wales of cases of Cerebro-spinal Fever during the last 18 weeks of the year 1914.*

—	September.				October.					November.				December.				Jan.	Total.
	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	
London	3	4	2	1	–	-	1	–	2	2	–	–	–	–	–	1	1	2	19
Bedfordshire—																			
Rural Districts	–	–	–	–	.	–	–	–	–	–	–	–	–	–	–	1	–	–	1
Cheshire—																			
Wallasey, C. B.	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1
Rural Districts	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
Devonshire—																			
Rural Districts	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1
Essex—																			
West Ham, C. B.	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
Urban Districts	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2
Gloucestershire—																			
Bristol, C. B. ...	–	–	1	–	–	2	–	–	–		–	–	–	–	–	–	1	–	4
Lancashire—																			
Liverpool C. B.	2	2	–	–	1	2	–	1	–	–	–	–	1	–	–	–	–	–	9
Manchester C. B.	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Salford C. B.	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Southport C. B.	–	–	–	–	–	–	–	–	.	–	1	–	–	–	–	–	–	–	1
Wigan C. B.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1
Urban Districts	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	2
Leicestershire—																			
Rural Districts	–	–		–	–	1	–	–	–	–	–	–	–	–	–	–	.	–	1

	September.				October.					November.				December.				Jan.	Total.
	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	
Middlesex—																			
Urban Districts	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Norfolk—																			
Norwich C. B.	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
Northumberland—																			
Tynemouth C. B.	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	2
Shropshire—																			
Urban Districts	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1
Somersetshire—																			
Urban Districts	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Rural Districts	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	2
Southants—																			
Urban Districts	–	–	–	–	–	–	1	–	–	–	–		–	–	–	–	–	1	2
Staffordshire—																			
Stoke-on-Trent C. B. ...	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1
Urban Districts	–	–	–	–	–	–	–	–	–	–	–	–	1		–	–	–	–	1
Suffolk East—																			
Ipswich C. B.	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
Rural Districts	–	–	–	–	–	–	–	1		–	–	–	–	–	–	–	–	–	1
Surrey—																			
Rural Districts	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	3

	September.				October.					November.				December.				Jan.	Total.
	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	
Sussex East—																			
Eastbourne C. B.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Urban Districts	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2
Warwickshire—																			
Birmingham C. B.	1	1	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	2	6
Wiltshire—																			
Urban Districts	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	–	4
Rural Districts	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
Worcestershire—																			
Urban Districts	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Yorkshire, East Riding—																			
Kingston on Hull C. B. ...	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1
Yorkshire, West Riding—																			
Bradford C. B.	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1
Urban Districts	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Glamorganshire—																			
Swansea C. B.	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2
Monmouthshire—																			
Urban Districts	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Total	10	8	8	1	3	7	2	5	6	2	2	1	5	–	1	9	9	6	85

TABLE III.—*Showing week by week for the first six months of the year 1915, the distribution of notified cases of cerebro-spinal fever in London and in County Boroughs and Urban and Rural Districts in Counties in England and Wales.*

—	January.				February.				March.				April.				May.					June.				July	Total.
	9	16	23	30	6	13	20	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	
London	4	6	4	4	5	12	15	13	24	20	27	30	21	41	43	32	20	33	20	18	12	19	15	12	7	12	468
Bedfordshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	2	—	—	—	—	—	—	5
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Berkshire—																											
Reading C. B.	—	—	1	—	—	—	—	—	—	2	—	9	4	2	2	4	1	4	5	3	5	2	2	—	4	4	54
Urban Districts ...	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	4
Rural Districts ...	—	—	—	—	1	—	—	—	1	3	1	2	2	1	2	—	1	—	—	1	—	—	—	—	1	—	16
Buckinghamshire—																											
Urban Districts ...	—	—	—	—	—	—	2	1	—	—	1	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	6
Rural Districts ...	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—	1	—	—	4
Cambridgeshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Cheshire—																											
Birkenhead C. B. ...	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Chester C. B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	2
Stockport C. B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wallasey C. B. ...	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Urban Districts ...	—	—	—	1	—	—	—	—	—	—	—	1	—	—	1	—	—	—	1	—	—	—	—	—	1	—	5
Rural Districts ...	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	2
Cornwall—																											
Urban Districts ...	—	—	—	—	—	—	—	—	2	2	2	2	3	—	—	1	—	—	—	—	1	—	1	—	—	—	14
Rural Districts ...	—	—	—	1	—	—	—	—	—	3	1	1	1	1	—	—	1	—	2	1	—	1	—	—	2	—	15
Cumberland—																											
Carlisle C. B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	2
Derbyshire—																											
Derby C. B.	—	—	—	—	—	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—	4
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	1	1	—	2	—	1	—	—	—	2	—	—	1	—	—	8

—	January. 9	16	23	30	February. 6	13	20	27	March. 6	13	20	27	April. 3	10	17	24	May. 1	8	15	22	29	June. 5	12	19	26	July 3	Total.
Devonshire—																											
Exeter C. B.	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	3
Plymouth C. B. ...	—	—	—	—	1	—	—	1	—	2	—	1	—	—	—	2	2	—	—	1	1	4	—	1	1	—	17
Urban Districts ...	1	—	—	—	—	—	—	—	—	1	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	5
Rural Districts ...	—	—	1	—	—	—	—	—	—	—	—	—	5	1	2	—	1	—	—	1	—	—	—	—	—	—	11
Dorsetshire—																											
Urban Districts ...	—	—	—	—	—	1	1	—	—	1	1	—	—	—	—	—	1	2	2	—	—	—	2	1	—	—	12
Rural Districts ...	—	1	—	—	7	1	2	1	1	—	1	—	—	1	4	—	4	2	3	1	—	—	—	—	—	—	29
Durham—																											
Darlington C. B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gateshead C. B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
South Shields C. B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sunderland C. B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
West Hartlepool C. B....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	2
Rural Districts ...	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	3
Ely, Isle of—																											
Urban Districts ...	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	1	—	—	—	3
Essex—																											
East HamC. B. ...	—	—	—	—	—	—	—	—	—	—	—	2	—	—	1	1	2	—	—	—	—	—	—	—	—	—	6
Southend-on-Sea C. B.	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	2
West Ham C. B. ...	—	—	—	—	1	2	—	3	1	4	1	1	—	2	—	2	—	—	—	—	—	1	—	—	1	—	19
Urban Districts ...	—	1	—	—	2	2	3	2	2	2	2	2	1	3	5	—	2	3	4	3	2	—	—	1	—	1	43
Rural Districts ...	—	—	—	—	1	—	1	1	5	3	1	1	5	5	2	2	1	—	2	—	—	—	—	—	—	—	30
Gloucestershire—																											
Bristol C. B.	—	1	1	2	2	3	—	7	4	6	8	3	3	2	1	—	1	2	5	1	2	2	2	—	2	1	61
Gloucester C. B. ...	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Urban Districts ...	—	—	—	—	—	—	1	—	—	—	—	1	—	2	4	2	2	—	1	—	—	—	1	—	—	—	14
Rural Districts ...	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	3
Herefordshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	3	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5

	January.				February.				March.				April.				May.					June.				July	Total.
—	9	16	23	30	6	13	20	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	
Hertfordshire—																											
Urban Districts ...	—	—	—	1	—	—	2	—	—	1	1	—	—	2	3	1	1	—	1	—	1	1	—	—	—	—	15
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	1	—	—	—	—	—	—	—	—	—	4
Huntingdonshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	1	—	—	2	—	—	—	—	1	1	—	—	—	—	—	—	—	5
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
Kent—																											
Canterbury C.B. ...	—	1	—	—	—	1	—	1	—	1	—	—	—	—	—	—	—	1	—	1	1	—	—	—	—	—	7
Urban Districts ...	—	—	1	—	1	1	3	7	4	6	6	1	6	3	6	2	4	3	1	1	2	3	—	3	2	—	66
Rural Districts ...	—	—	—	—	1	—	—	2	1	4	—	1	1	2	1	2	1	2	1	—	—	—	—	1	—	—	20
Lancashire—																											
Barrow in Furness C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Blackburn C.B. ...	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Blackpool C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
Bolton C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	2
Bootle C.B.	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	2
Burnley C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bury C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Liverpool C.B. ...	1	—	—	—	—	—	—	—	1	—	1	—	—	2	—	1	2	1	2	3	1	2	2	1	—	—	20
Manchester C.B. ...	1	—	—	—	—	—	—	—	—	—	2	—	—	2	2	1	2	2	—	—	—	—	—	—	—	—	12
Oldham C.B.	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	1	—	—	—	—	—	—	3
Preston C.B.	—	—	—	—	1	—	—	2	1	1	1	—	—	1	—	—	1	—	—	—	—	1	—	—	—	—	9
Rochdale C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
St. Helens C.B. ...	—	—	—	—	—	—	—	1	1	—	—	—	2	1	1	—	—	—	—	—	—	—	—	—	—	1	7
Salford C.B.	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	1	1	1	—	—	—	1	6
Southport C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Warrington C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
Wigan C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urban Districts ...	1	—	1	—	2	2	—	1	—	2	2	—	—	3	2	6	3	—	2	1	—	—	1	—	—	1	30
Rural Districts ...	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	1	—	—	4
Leicestershire—																											
Leicester C.B. ...	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	4
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—	—	—	3
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

—	January.				February.				March.				April.				May.					June.				July	Total.
	9	16	23	30	6	13	20	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	
Lincolnshire—Holland—																											
Urban Districts ...	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Rural Districts ...	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Lincolnshire—Kesteven—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lincolnshire—Lindsey—																											
Grimsby C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
Urban Districts ...	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Rural Districts ...	—	—	—	—	2	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	4
Middlesex—																											
Urban Districts ...	1	1	—	—	—	2	1	3	8	6	4	9	3	8	6	7	4	5	5	4	3	3	2	—	2	3	90
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1	—	—	1	—	—	1	—	—	—	—	—	5
Norfolk—																											
Great Yarmouth C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Norwich C.B.	—	—	—	2	—	—	2	3	—	—	1	2	1	—	1	2	2	1	—	—	1	1	—	—	—	—	19
Urban Districts ...	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Rural Districts ...	—	—	—	2	—	—	—	2	1	—	—	2	—	4	1	—	1	—	—	—	—	—	1	1	—	—	15
Northamptonshire—																											
Northampton C.B. ...	—	—	—	—	—	—	—	—	—	1	—	1	1	—	1	—	2	—	1	—	—	—	—	1	—	—	8
Urban Districts ...	—	—	—	—	—	—	—	2	—	1	—	2	1	—	1	—	—	—	—	1	—	—	—	—	—	—	8
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	4
Northumberland— ...																											
Newcastle-on-Tyne C.B.	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	1	—	—	1	5
Tynemouth C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urban Districts ...	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	3
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1
Nottinghamshire—																											
Nottingham C.B. ...	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	1	1	—	1	1	—	—	—	—	—	6
Urban Districts ...	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	3
Rural Districts ...	—	—	—	—	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	4

	January.				February.				March.				April.				May.					June.				July	Total.
—	9	16	23	30	6	13	20	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	
Oxfordshire—																											
Oxford C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urban Districts ...	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	1	—	—	—	—	—	3
Peterborough, Soke of—																											
Urban Districts ...	—	—	—	—	—	—	—	1	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rutlandshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Shropshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	2
Somersetshire—																											
Bath C.B. ...	—	—	—	—	—	—	2	2	—	2	1	—	—	1	—	1	—	—	—	1	1	—	—	—	—	—	11
Urban Districts ...	—	—	1	—	—	—	1	1	2	—	1	—	—	1	1	—	4	1	1	—	—	—	—	—	—	—	14
Rural Districts ...	—	—	—	—	2	1	1	1	1	1	2	1	—	—	4	—	1	—	—	—	1	1	1	—	—	—	18
Southampton Co.—																											
Bournemouth C.B. ...	—	—	—	—	—	—	—	1	—	2	1	1	2	—	—	2	1	—	—	—	—	—	—	—	—	—	10
Portsmouth C.B. ...	—	—	—	—	—	1	4	8	6	11	3	6	4	—	5	4	1	3	3	1	—	—	—	2	—	—	62
Southampton C.B. ...	—	—	—	—	—	—	—	1	1	—	3	—	—	—	2	1	—	—	—	1	—	—	—	—	1	—	10
Urban Districts ...	—	—	1	2	6	2	6	2	6	8	6	4	3	3	3	2	1	—	1	1	—	1	3	1	2	—	64
Rural Districts ...	—	—	—	—	1	—	3	8	2	4	2	—	2	1	5	1	1	—	1	1	—	—	1	1	—	1	35
Staffordshire—																											
Burton upon Trent C. B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Smethwick C.B. ...	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	2	—	1	—	—	—	5
Stoke on Trent C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Walsall C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
West Bromwich C.B. ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wolverhampton C.B. ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	2
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	1	—	1	—	—	—	—	4
Rural Districts ...	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	1	—	—	—	—	—	1	—	—	4

—	January.				February.				March.				April.				May.					June.				July	Total.
	9	16	23	30	6	13	20	27	6	13	20	27	3	10	17	21	1	8	15	22	29	5	12	19	26	3	
Suffolk, East—																											
Ipswich C.B.	—	—	—	—	—	1	1	—	1	1	4	—	—	—	—	1	4	4	—	2	—	—	—	—	1	—	20
Urban Districts ...	—	—	—	—	1	2	—	—	1	1	1	1	1	—	1	—	—	—	—	—	—	—	—	—	—	1	10
Rural Districts ...	—	—	—	—	—	—	—	1	2	—	—	—	—	1	1	—	—	—	—	1	—	—	—	—	—	—	6
Suffolk, West—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	1	—	—	—	3
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	2
Surrey—																											
Croydon C.B.	—	—	—	—	—	1	2	—	4	—	—	1	2	—	3	1	1	—	—	3	3	2	—	—	—	—	23
Urban Districts ...	—	—	—	—	1	—	1	5	1	3	3	3	1	2	2	3	3	—	—	1	1	1	2	1	1	3	38
Rural Districts ...	—	1	—	1	—	1	1	—	2	4	2	2	—	1	—	—	1	—	1	—	—	—	1	—	—	—	18
Sussex, East—																											
Brighton C.B. ...	—	—	—	—	—	1	1	—	1	4	2	5	1	3	7	1	3	1	2	—	2	—	—	—	—	—	34
Eastbourne C.B. ...	—	—	—	—	—	—	1	1	—	1	1	—	—	—	—	—	—	2	—	—	—	—	—	—	2	—	8
Hastings C.B. ...	—	—	—	—	1	—	—	—	—	1	—	—	—	1	1	—	1	—	—	—	—	—	—	—	—	—	5
Urban Districts ...	—	—	—	1	1	1	1	—	2	—	2	2	3	1	—	3	—	—	1	1	—	—	—	—	—	—	19
Rural Districts ...	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	3
Sussex, West—																											
Urban Districts ...	—	—	—	—	—	2	—	1	—	1	—	—	1	2	1	1	—	—	—	—	—	—	—	—	1	—	10
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	3
Warwickshire—																											
Birmingham C.B. ...	—	—	—	—	—	—	—	—	1	2	—	4	5	3	4	2	5	1	—	2	1	1	2	1	2	1	37
Coventry C.B. ...	—	—	—	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	—	1	—	—	—	1	—	—	5
Urban Districts ...	—	—	—	1	—	—	—	4	4	1	3	1	1	—	3	1	1	2	1	1	2	1	1	—	—	2	30
Rural Districts ...	—	—	—	—	—	—	—	1	1	1	—	1	—	—	1	1	1	—	—	—	1	—	—	—	—	—	8
Westmorland—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	1	—	—	—	—	—	—	—	—	—	3
Wight, Isle of—																											
Urban Districts ...	—	—	—	—	—	—	3	—	1	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	6
Rural Districts ...	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	2
Wiltshire—																											
Urban Districts ...	1	4	2	1	1	5	10	5	1	1	—	1	2	3	5	4	1	2	—	2	—	—	—	—	—	1	52
Rural Districts ...	1	—	—	2	4	6	3	2	3	1	1	6	2	1	3	—	2	3	1	—	1	—	1	—	—	—	43

	January.				February.				March.				April.				May.					June.				July	Total.
	9	16	23	30	6	13	20	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	
Worcestershire—																											
Dudley C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worcester C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	3
Rural Districts ...	—	—	—	—	1	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	1	1	—	—	—	—	6
Yorkshire, East Riding—																											
Kingston-upon-Hill C.B.	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	—	—	—	—	—	—	—	—	—	—	3
York C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urban Districts ...	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Yorkshire, North Riding—																											
Middlesbrough C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	2
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	3
Rural Districts ...	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Yorkshire, West Riding—																											
Barnsley C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	2
Bradford C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dewsbury C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Halifax C.B.	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Huddersfield C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
Leeds C.B.	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	3
Rotherham C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield C.B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Wakefield C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urban Districts ...	—	—	—	—	—	—	1	1	3	—	1	—	—	1	—	—	1	—	—	—	—	—	—	—	—	1	9
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
Anglesey—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Brecknockshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiganshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

—	January. 9	16	23	30	February. 6	13	20	27	March. 6	13	20	27	April. 3	10	17	24	May. 1	8	15	22	29	June. 5	12	19	26	July 3	Total.
Carmarthenshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	3	—	4
Carnarvonshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
Denbighshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Flintshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1	—	—	—	—	1	—	—	—	—	4
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	2
Glamorganshire—																											
Cardiff C.B.	—	—	—	—	—	—	—	—	—	—	1	—	—	3	1	1	1	2	3	1	1	1	—	1	—	—	16
Merthyr Tydfil C.B. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Swansea C.B.	—	—	—	—	—	—	3	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
Urban Districts ...	—	—	—	—	—	—	—	—	—	1	2	2	1	2	2	1	—	1	2	—	1	—	1	1	—	—	17
Rural Districts ...	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	3
Merionethshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monmouthshire—																											
Newport C.B. ...	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	2
Urban Districts ...	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	3	1	—	—	—	—	—	—	—	—	—	6
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Montgomeryshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pembrokeshire—																											
Urban Districts ...	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
Radnorshire—																											
Urban Districts ...	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Rural Districts ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Port Sanitary Districts ...	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	1	—	6
Totals	11	22	15	25	48	52	83	108	118	133	121	138	111	130	163	117	114	98	84	76	60	56	49	38	38	37	2,045

TABLE IV.—*Showing week by week the notifications of cases of cerebro-spinal fever (excluding military cases) in London during the 26 weeks ended 3rd July, 1915, with their distribution in each of the metropolitan boroughs.*

—	January.				February.				March.				April.				May.					June.				July	Total.
	9	16	23	30	6	13	20	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	
London, City of	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Battersea	—	—	—	1	—	—	2	—	3	—	1	—	—	1	1	1	1	2	2	1	—	2	—	1	1	—	20
Bermondsey	—	—	—	—	1	—	—	—	—	2	—	—	—	1	6	1	1	1	—	—	—	—	1	—	—	—	14
Bethnal Green	1	—	1	—	—	—	1	—	—	1	2	—	1	2	—	1	—	—	1	—	1	2	1	—	—	1	16
Camberwell	—	1	—	—	—	—	—	—	1	2	1	1	1	—	2	3	—	1	2	1	1	2	1	—	2	—	22
Chelsea	—	—	—	—	—	—	—	—	—	1	—	—	—	2	1	—	1	—	—	—	—	1	—	—	—	—	6
Deptford	—	—	—	—	—	1	1	—	—	—	—	2	1	2	—	2	—	—	—	—	1	1	—	—	—	—	11
Finsbury	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	2	—	1	—	—	—	—	1	—	1	—	6
Fulham	—	1	—	—	—	—	—	—	1	—	1	2	—	1	—	1	—	—	1	—	2	1	—	—	—	—	11
Greenwich	—	—	—	—	—	—	1	—	1	—	2	—	—	1	2	1	1	1	—	—	—	—	—	—	—	—	10
Hackney	—	—	—	—	—	1	—	1	2	1	1	1	1	5	1	1	4	2	—	—	—	1	3	3	—	—	28
Hammersmith	—	—	—	—	—	—	1	—	—	1	1	—	2	4	1	1	—	3	2	1	—	—	—	—	—	—	17
Hampstead	—	—	—	—	—	1	1	1	—	1	—	—	1	1	—	1	1	1	1	—	—	—	—	—	—	—	10
Holborn	—	—	—	—	—	1	—	—	—	—	—	—	2	1	—	—	—	—	—	2	—	—	—	—	—	—	6
Islington	—	2	1	—	1	—	—	—	1	—	1	4	1	1	3	2	—	3	—	1	—	—	1	1	—	1	24
Kensington	—	—	—	—	—	2	—	2	1	1	4	1	—	5	1	3	3	2	1	2	2	—	1	1	1	—	33
Lambeth	—	1	—	—	1	—	2	3	1	—	—	2	2	1	5	1	3	2	1	1	—	2	1	1	—	4	34
Lewisham	—	—	1	—	—	—	1	—	—	—	1	2	—	1	1	—	—	—	—	—	—	2	—	—	—	—	9
Paddington	2	1	—	—	—	—	2	1	1	1	—	—	1	—	1	—	—	—	—	1	1	—	1	—	—	—	13
Poplar	1	—	1	—	—	1	—	—	—	1	—	1	3	1	—	—	—	—	1	1	—	2	1	1	—	2	17
St. Marylebone	—	—	—	—	—	—	—	—	1	—	1	—	1	—	2	—	—	1	—	—	—	—	—	—	—	1	7
St. Pancras	—	—	—	1	—	—	1	2	5	2	1	2	1	1	3	—	—	1	1	1	1	—	2	—	—	1	26
Shoreditch	—	—	—	—	—	—	—	—	1	—	1	4	2	2	3	1	—	2	3	1	—	1	1	—	—	—	22
Southwark	—	—	—	—	—	1	—	2	1	1	—	1	—	5	2	2	1	—	—	—	—	—	—	1	—	—	17
Stepney	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	2	—	2	—	1	2	2	—	—	1	2	14
Stoke Newington	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	1	—	—	—	—	—	—	3
Wandsworth	—	—	—	1	2	2	—	—	1	2	4	1	1	3	4	2	3	2	3	3	1	—	—	3	1	—	39
Westminster...	—	—	—	1	—	—	1	1	2	—	—	2	—	—	1	2	—	1	1	—	—	—	—	—	—	—	12
Woolwich	—	—	—	—	—	1	1	—	—	2	5	3	—	—	3	2	1	3	—	—	—	—	—	—	—	—	21
Total	4	6	4	4	5	12	15	13	24	20	27	30	21	41	43	32	20	32	20	18	12	19	15	12	7	12	468

TABLE V.—*Showing the cases of cerebro-spinal fever (excluding military cases) in London during the 26 weeks ended 3rd July, 1915, with age and sex distribution of these cases in each of the metropolitan boroughs.*

—	0—		1—		2—		3—		4—		5—		6—		7—		8—		9—		10—		15—		20—		25—		30		All ages.		Total
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
City of London	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	—
Battersea	–	1	2	1	1	–	–	2	–	–	–	1	–	1	–	2	–	–	–	1	–	1	2	1	–	–	1	1	2	–	8	12	20
Bermondsey	2	–	–	2	–	2	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	1	–	1	1	1	1	–	–	1	4	10	14
Bethnal Green	2	1	2	2	–	–	–	1	1	1	–	1	–	1	–	–	–	–	–	–	1	1	1	–	–	–	–	1	–	–	7	9	16
Camberwell	3	1	1	–	–	–	–	–	1	1	1	2	1	–	–	–	–	–	–	1	1	2	2	–	–	1	–	1	3	–	13	9	22
Chelsea	–	–	1	–	–	–	–	–	1	1	–	–	–	1	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	2	4	6
Deptford	2	–	1	–	–	–	–	1	–	–	1	–	–	1	–	–	–	1	–	–	1	–	–	1	–	–	–	–	1	1	6	5	11
Finsbury	–	1	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	1	–	4	2	6
Fulham	3	–	–	–	2	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	1	–	–	2	–	1	–	10	1	11
Greenwich	1	–	–	1	–	–	1	–	1	–	–	–	–	1	–	–	–	–	2	–	1	–	–	–	1	–	1	–	–	–	8	2	10
Hackney	4	–	1	1	–	–	–	2	3	–	–	–	–	–	1	1	–	–	1	2	2	1	–	1	2	1	–	–	2	3	16	12	28
Hammersmith	1	3	–	1	–	–	–	–	–	2	–	–	–	1	2	–	1	–	–	–	–	–	2	1	–	1	1	–	1	–	8	9	17
Hampstead...	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	2	1	1	–	2	2	6	4	10
Holborn	–	1	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	1	–	3	3	6
Islington	3	2	1	2	1	1	1	–	–	–	2	1	–	–	–	–	–	–	1	–	1	–	1	1	–	1	1	–	1	3	13	11	24
Kensington...	4	3	2	1	2	4	1	–	1	–	1	1	–	–	–	1	–	–	–	–	3	2	1	–	–	–	–	–	4	2	19	14	33
Lambeth	5	1	2	2	2	–	2	–	–	1	–	2	1	1	–	1	–	–	–	–	2	1	3	3	–	1	–	1	3	–	20	14	34
Lewisham	1	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	2	–	–	2	1	–	–	–	1	–	6	3	9
Paddington	2	–	2	1	–	–	1	–	–	–	–	–	–	–	–	–	–	1	1	–	–	2	–	–	1	–	–	1	1	–	8	5	13
Poplar	3	3	–	1	1	–	–	1	–	–	1	2	–	–	–	–	–	2	–	–	–	–	–	–	1	1	–	–	–	1	6	11	17
St. Marylebone	1	–	–	–	–	1	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	1	4	3	7
St. Pancras...	1	1	1	2	–	1	–	–	2	1	–	1	1	2	1	–	1	–	–	1	–	3	2	1	–	–	–	1	1	2	10	16	26
Shoreditch	7	–	2	1	2	–	–	1	–	1	–	–	–	–	–	2	–	–	–	–	2	1	–	1	1	–	–	–	1	–	15	7	22
Southwark	2	–	–	–	–	–	1	1	–	–	1	–	–	1	–	1	–	–	2	–	–	–	2	4	–	–	–	–	1	1	9	8	17
Stepney	4	2	–	–	–	–	–	–	–	–	–	1	1	–	1	–	–	–	–	–	1	2	–	1	1	–	–	–	–	–	8	6	14
Stoke Newington	1	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	3
Wandsworth	1	3	1	2	1	–	1	1	1	2	3	–	1	–	–	–	–	–	1	2	5	3	1	1	1	3	1	–	1	3	19	20	39
Westminster	1	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	2	–	–	–	1	–	2	1	10	2	12
Woolwich	2	–	–	1	1	–	1	–	–	–	1	–	1	1	–	–	–	–	–	–	2	2	–	–	2	–	–	1	3	3	13	8	21
Total	56	23	20	24	14	10	9	10	11	12	12	12	9	13	6	9	3	5	8	8	27	23	21	20	16	11	11	7	34	24	257	211	468

VI.—The Prevalence and Distribution of Cerebro-Spinal Fever throughout the World during Recent Years; by Dr. R. Bruce Low.

Introductory.

Owing to its prevalence, during 1914 and 1915, amongst the civil and military population of this country, public attention was specially directed to the disease formerly known as epidemic cerebro-spinal meningitis or simply as epidemic meningitis, but now more commonly termed cerebro-spinal fever. Accordingly, it has been deemed useful to prepare in the Medical Department a connected account, as far as is practicable, of the appearances of this disease in one or another part of the world during recent years—to supplement, that is, the history of the malady which the late Professor Hirsch published in his classical Handbook of Historical and Geographical Pathology in 1886.

The present account does not claim to be by any means complete; it summarises, however, the material on the subject available in the various records and reports received by the Medical Department of the Board.

Since 1886 considerable advance has been made in our knowledge of cerebro-spinal fever. In 1887 Professor Weichselbaum, of Vienna, demonstrated, in the lesions induced by this malady, the presence of a definite micro-organism, the diplo-coccus intracellularis, which is now generally accepted as the particular cause of cerebro-spinal fever. For some years, however, not much use was made of the bacteriological test in identifying cerebro-spinal fever, and more abundant employment of the test revealed the fact that the diplo-coccus in question is not peculiar to cerebro-spinal meningitis. In 1898 Dr. Still, of London, and subsequently other observers, found this same organism associated with the lesions of simple posterior basal meningitis, a disease almost solely of infants; while later on, Weichselbaum's diplo-coccus, now commonly termed the "Meningo-coccus," was detected colonising the naso-pharynx of groups of persons not ill at all, or only suffering from comparatively trivial ailments.

For various reasons the records of past years regarding cerebro-spinal fever are not to be regarded as altogether trustworthy. Outbreaks have escaped recognition owing to lack of familiarity with the symptoms of the disease on the part of the members of the medical profession in the invaded district. In particular instances the majority of persons attacked have suffered from the characteristic symptoms of the disease, including pain and stiffness in the neck, often leading to retraction of the head, which latter symptom has given to the malady in some countries the name of "the stiff-neck fever" or "epidemic neck-cramp." In not a few outbreaks, however, though some of the persons attacked have developed the marked features of the disease, many others have suffered concurrently from a mild form of illness with nasal catarrh, tonsillitis or influenza-like symptoms. As a result, certain French authorities at one time sought to prove that epidemic cerebro-spinal meningitis was closely related to influenza. Some observers recognise as cerebro-spinal fever only those cases in

which the characteristic symptoms are present, while others regard the concurrent catarrhal illness as due to the same infection, and therefore to be regarded as a milder manifestation of the same disease. Again, there has been suspicion that cases regarded locally as cerebro-spinal fever were really instances of epidemic poliomyelitis and *vice versa*. Study of the bacteriology of cerebro-spinal fever and of the biology of the meningo-coccus, while furnishing valuable assistance in facilitating the diagnosis of the malady, has emphasised the fact of the frequent presence of the meningo-coccus in the naso-pharynx of persons suffering from minor illness, as also in the discharges from the nose and throat of healthy persons who have associated with infected patients. The spread of the meningo-coccal infection by such carriers, too, has been clearly established. Prior to the practical application of modern bacteriology to the diagnosis of cerebro-spinal fever—that is, by adoption of lumbar puncture and bacteriological test of the exuded cerebro-spinal fluid—great difficulties were experienced in the recognition of certain cases. There is no characteristic rash as in some other specific fevers, though spots of one or another kind, purpuric, petechial, herpetic or other, may be present; but in many cases there is no eruption at all, so that the popular name "spotted fever," used largely by the lay press, is both incorrect and misleading. Moreover, it is not to be denied that symptoms indistinguishable from those of cerebro-spinal fever may be observed in other acute infections, such as acute poliomyelitis, enteric fever, measles or pneumonia, in instances where the pathogenic organisms have penetrated to the surface of the brain. Prior to 1895 such cases might have been erroneously certified as epidemic cerebro-spinal meningitis. As has been said, such mistakes are not likely to occur at the present day, when bacteriology is properly employed to confirm or negative the diagnosis. It is extremely probable, however, that, if not at the present day, at least in previous years, deaths really due to cerebro-spinal fever have been certified simply as meningitis, inflammation of the brain, or under other designations, and that in this way the mortality returns do not always show the full extent of the fatal prevalence of the disease in a given district. The great diversity in the virulence of particular outbreaks has given rise to the assumption that several strains of the meningo-coccus may be current in different places, strains varying in their degrees of intensity, as well as differing slightly in their cultural characters, as also serologically. It is held that the meningo-coccus has certain properties which make it extremely improbable that the organism can maintain a saprophytic life outside the human body. It is especially susceptible to cold and to drying; it has never, so far, been isolated from dust, air or fomites; its short-lived character therefore renders the possibility of its transmission by these means very remote.

The nose and the throat are now regarded as the portals of entrance of the meningo-coccus into the human body; that thence, in susceptible persons, it invades the blood stream, causing a meningo-coccal septicæmia with subsequent location of the micro-organism in the meninges. Some maintain that the organism reaches the meninges through the sphenoidal sinus. An

American authority* states that early in the disease the meningo-coccus may be found in the urine. The specific organism has also been found in the eye-secretions, and in the contents of herpetic vesicles, occurring in the course of the malady. Fatigue is cited as an important predisposing cause, and some observers insist on the importance of climatic conditions, holding that the development of a cerebro-spinal fever epidemic on a large scale is frequently preceded by a spell of cold and wet weather, which, by inducing catarrhs in the naso-pharynx, prepares the way for the reception of the specific organism. In this connection it is to be noted that the disease is most prevalent in the winter and spring months. The chief sufferers in many outbreaks have been children, though in many epidemics there has been a heavy and special incidence upon troops in barracks. In other instances, the inmates of prisons, orphanages, or other institutions have especially suffered. Most authorities are agreed that sustained and intimate contact with a person suffering from the disease, or with a chronic carrier, is the likeliest way in which the infection is spread from person to person.

The most conspicuous epidemics have occurred chiefly in Germany and in the United States of America, but, occasionally, as will be seen later, grave epidemics have been observed in other countries. For the most part, the disease occurs sporadically and in small groups of cases; frequently the attacks in a locality are limited to a single person in each house that is invaded. Sporadic cases, the origin of which cannot be traced to previous infection, are common. It is believed that insanitary conditions, including overcrowding and insufficient ventilation, predispose to the disease, partly by inducing respiratory troubles and by lowering the resistance of the individual. It is stated that cerebro-spinal fever can be found in sporadic form in nearly all the large cities of the United States during the cold season of each year.

Since cases of illness of a minor kind, presenting no marked cerebro-spinal symptoms, are now referred to infection by the meningo-coccus, the question has arisen whether the term "cerebro-spinal fever" is the most appropriate name for this malady. It has been suggested that a better name would be "meningo-coccal fever" or "meningo-coccal infection." It remains to be mentioned that persons attacked are sometimes left on their recovery with paralysis of one or more limbs, or with deafness, or with squinting or other defects of vision; sometimes the mental condition of the patient is left impaired. These after-effects may gradually disappear, but in some instances they are permanent.

CEREBRO-SPINAL FEVER IN THE BRITISH ISLES.

England and Wales.

Little was known respecting cerebro-spinal fever in England and Wales prior to 1865, when public attention was directed to the disease by the reported occurrence of a virulent epidemic in the valley of the Vistula. As some anxiety was felt as to the possible extension of the disease to this country, the Privy Council,

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* Dr. A. Sophian, of New York.

at that time the central health authority for England and Wales, despatched a medical inspector, Dr. Burdon Sanderson, to Germany to make inquiries, and his report upon the outbreak added much to the knowledge of the disease. About the same time groups of cases were reported from several English districts, including London and Rochester. In a memorandum prepared in 1865 by Sir John Simon, the Medical Officer to the Privy Council, it was stated that the disease was one of which England had hitherto had little experience, so that it was to be regarded as practically a new disease. It was also stated that although it was possible that small local outbreaks might have occurred before 1865 in this country, they had passed unrecognised and were therefore unrecorded. The malady could not, however, have prevailed to any great extent, and consequently it was, up to 1865, almost unknown to most of the medical practitioners in England and Wales. Clemow, in his "Geography of Disease," states that cerebro-spinal fever is a very rare disease in England, and that in the past only occasional and slight epidemics have been recorded. Generally the British Isles have been far less affected by the malady than have most of the other European countries. In 1866 an outbreak occurred at Bardney, a village about ten miles from Lincoln, but nothing more was heard of the disease until 1876, when several groups of cases were reported in the medical journals as having been observed at Birmingham, Bath, Plymouth, and Oxford. At the last-named place a few cases occurred among the militia who were then assembled for their annual training. In the winter of 1885–86 an outbreak was reported at Devonport among the garrison and among the men serving on board the warships moored in the harbour. During the same winter, cases occurred at Chester barracks.

In 1887 the medical press published accounts of a number of scattered cases in which cerebro-spinal symptoms were observed, and in which the clinical characters and post-mortem appearances suggested strongly that these were genuine instances of cerebro-spinal fever.

From 1887 to 1893 a series of ten fatal cases came under the notice of Dr. Ormerod in London at St. Bartholomew's Hospital, details of which he published in the *Lancet* during March, 1895. In 1890, groups of cases came under notice in Cambridgeshire, Monmouthshire and in Leeds, and during the summer of that year a series of localised occurrences of cerebro-spinal meningitis in the Eastern counties came under investigation by the Medical Department of the Local Government Board, including some cases in a group of villages on the borders of Suffolk and Norfolk, where some twenty recognised cases were under observation. In Essex several cases were reported, and some others in certain villages in Lincolnshire. In 1891, small groups of cases were observed in Shropshire and in Hertfordshire. In Market Rasen, a small urban district, the borders of which touch those of the Lincoln Rural District, there occurred a number of cases of illness, some of which had marked cerebro-spinal symptoms, while in others the patients suffered from feverish attacks and prostration, the malady being regarded at the time as "influenza." The outbreak began in December, 1890, among adults; in June, 1891, a considerable

number of children exhibited serious symptoms, including retraction of the head, and 17 of them who recovered were affected with paralysis of one or another kind.* In the same year a widespread epidemic of anomalous illness, chiefly affecting children, occurred at Raunds, in Northamptonshire, and in the neighbouring village of Heyford, as well as elsewhere in the same county. Suspicion arose that, although the majority of the cases suffered from a catarrhal illness and some from tonsillitis and pneumonia, the disease might be cerebro-spinal fever, since some of the cases exhibited pain and stiffness in the neck and others had retraction of the head. No bacteriological investigation being available at that time, the true nature of the epidemic was never ascertained; but in the light of recent knowledge of the disease it is not unlikely that this outbreak, which affected more than 300 persons, was due to meningo-coccal infection. In 1892 some suspicious cases were heard of in Nottinghamshire, and during 1893 several groups of what seemed to be cerebro-spinal fever cases were reported in Wiltshire and in Essex.

In 1894 an outbreak in Suffolk, at Laxfield and neighbourhood, similar to that at Raunds, was investigated by the Board's Medical Department. It affected 66 persons, mostly children. As in Raunds, the majority of those attacked had no cerebro-spinal symptoms, but, on the other hand, in some cases, retraction of the head, and in others, pain and stiffness of the neck were observed. It is possible that this outbreak, too, may have been due to a meningo-coccal infection; but, as no bacteriological examination was available at that date, the true nature of the disease remains uncertain. In 1895 a small outbreak of cerebro-spinal fever was reported to the Board by a medical officer of health in Lancashire. During 1897 a number of cases suspiciously resembling cerebro-spinal fever were heard of in various districts of Lincolnshire. Some of them were regarded by the local medical practitioners as "influenza with cerebro-spinal meningitis"; in other cases which were diagnosed as influenza, a purpuric eruption had been observed, and some of the patients who died had suffered from retraction of the head. In 1898, 30 persons in a Buckinghamshire village were attacked by an illness of an anomalous kind, the symptoms of which suggested cerebro-spinal fever. The patients were seen by four medical men who could not decide what was the true nature of the epidemic; it might, like the outbreaks at Raunds and Laxfield, have been due to an infection by the meningo-coccus. During 1902, cases of what was regarded as cerebro-spinal fever occurred at Devonport on board some warships, and, in 1903, an epidemic of illness affecting about 80 children and resembling cerebro-spinal fever, was investigated by the Medical Department of the Board in the Ellesmere and Oswestry Rural Districts, in Shropshire. The symptoms varied in intensity in different cases. On the whole, the outbreak resembled that at Raunds already mentioned. Some of the fatal cases were certified as "acute meningitis" by one

* It is, however, possible that this outbreak, judging from the comparatively large proportion of paralysed cases, was in reality one of epidemic poliomyelitis, a disease at that time little known in England.

local practitioner, while another diagnosed his cases as "epidemic cerebro-spinal meningitis." A group of six cases of cerebro-spinal fever occurred in Sussex, in the Uckfield Rural District in 1902, and four fatal cases were reported at Spilsby, Lincolnshire, in 1903. An outbreak, comprising about 30 marked cases at Irthlingborough, a small town in Northamptonshire, was brought to the notice of the Local Government Board in 1905. There were also in this instance, coincidently with the unequivocal cases, several others of anomalous sort, mostly among persons who had been in direct contact with one or other of the patients who were seriously ill. These anomalous cases resembled acute influenza, and all recovered. In this outbreak resort was had to bacteriological investigation, which was conducted on behalf of the Board by an expert, Dr. Mervyn Gordon, who found in the nasal mucus, or in the cerebro-spinal fluid, the meningo-coccus of Weichselbaum; so that the diagnosis of cerebro-spinal fever was established beyond dispute. This is the more interesting from the fact that the serious cases and those with only influenza-like symptoms occurred side by side, both classes of cases being apparently due to the same meningo-coccal infection. The Irthlingborough outbreak seems to throw some light on such previous outbreaks as those at Raunds and Heyford, Laxfield, Ellesmere and Oswestry, and elsewhere. If expert bacteriological investigation had been available in these instances, it is more than probable that they would have been proved to be associated with the meningo-coccal infection.

In 1911 a localised outbreak, comprising 18 cases and four deaths, occurred in the Ely district, Cambridgeshire, all the patients being children.

In 1912 the notification of cerebro-spinal fever became compulsory in England and Wales, and 272 cases were reported in that year; in 1913 there were 304 notifications, and in 1914 315. There was a considerable increase in the number of cases of cerebro-spinal fever notified during the first half of 1915, no fewer than 2,043 notifications being received, the total for the year amounting to 2,565. The increased incidence upon the civil population was accompanied by a correspondingly high number of attacks upon the troops undergoing their training in various parts of the country.

Dr. T. H. C. Stevenson, in his review of the vital statistics for 1913, in the Registrar-General's Annual Report for that year, states that the mortality ascribed to cerebro-spinal fever has increased of recent years. From 1901 onwards, inquiry began to be made in the Registrar-General's office as to deaths certified as due to cerebro-spinal meningitis, with the result that there was transfer of a greatly increased number of deaths from "cerebro-spinal meningitis" to cerebro-spinal fever. In England and Wales the deaths attributed to the disease do not exceed 100 in any year until 1905, in which year the number was 127. In 1906 71 deaths were recorded, but since that date the number has never been below 100, the figure for 1913, viz., 163, being the highest recorded. If the deaths from posterior basal meningitis are reckoned along with those from cerebro-spinal fever, the total mortality ascribed to meningo-coccal infection is raised to 9 per million, but it has to be borne in mind that, prior to 1911, these

deaths were classed to meningitis, not to cerebro-spinal fever, and that the words "posterior basal or basic" are sometimes used merely to signify the location of the disease indicated, without any implication that it is of meningococcal origin. It is probable, Dr. Stevenson adds, that the majority of deaths due to meningo-coccic meningitis are returned simply as meningitis and are so allocated to the heading "Meningitis, other forms."

The following table gives the number of deaths certified as due to cerebro-spinal fever in England and Wales from 1877 to 1894:—

Year.	Deaths.	Year.	Deaths.	Year.	Deaths.
1877	46	1883	38	1889	23
1878	58	1884	32	1890	38
1879	46	1885	27	1891	31
1880	43	1886	40	1892	29
1881	34	1887	24	1893	13
1882	42	1888	18	1894	23
6 years.	269	6 years.	179	6 years.	157

The next table which is compiled from the figures given by the Registrar-General, shows the number in each instance of deaths certified in England and Wales from meningitis or inflammation of the brain, tuberculous meningitis, and cerebro-spinal fever in each of the 19 years, 1895 to 1913 inclusive.

Year.	Deaths from Meningitis, Inflammation of the Brain.	Deaths from Tuberculous Meningitis.	Deaths from Cerebro-spinal Fever.
1895	7,561	6,746	23
1896	7,284	6,475	11
1897	7,429	6,606	10
1898	7,556	6,681	11
1899	7,555	6,449	21
1900	7,636	6,395	9
1901	7,073	5,954	59
1902	6,572	5,961	60
1903	6,341	6,476	68
1904	6,301	6,389	81
1905	6,034	6,083	127
1906	5,997	6,104	71
1907	5,429	5,885	161
1908	5,516	5,868	116
1909	5,344	5,774	130
1910	5,006	5,471	132
1911	5,412	5,245	134
1912	4,153	5,001	142
1913	4,399	5,016	163

As mentioned already, the compulsory notification of cerebro-spinal fever cases did not come into operation for the whole of England and Wales until September 1st, 1912, but before that time a number of sanitary authorities had at various dates added

the disease to the list of notifiable diseases under the Infectious Diseases Notification Act of 1889. Under the incomplete system of notification existing in 1911, 134 cases were reported in England and Wales, and, in 1912, 272 cases came under official observation, 104 of which were certified after the date on which the Board's Order making the notification of cerebro-spinal fever obligatory throughout England and Wales came into operation. During 1913, 304 cases were notified, and in 1914, 315. Of those notified in 1913, 295 occurred in England and 9 in Wales; and, in 1914, the numbers were 304 and 11 respectively. In 1915, prevalence of cerebro-spinal fever was reported in various camps in which the recruits for the new armies were being trained, also, as has already been said, among the civil population in different parts of the country. At Winchester, for example, an outbreak developed in January and continued till April, 22 civil cases being reported; in Salisbury during the same period some 40 civilians were attacked, and at Portsmouth 39 of the civil population as well as 19 soldiers and 8 men of the Royal Navy contracted the disease, making 66 cases during the first quarter of 1915. At Brighton Dr. D. Forbes and Dr. D. C. Adam treated 51 cases in the isolation hospital in the earlier months of 1915; 23 of these patients died.

Although the disease was present in England and Wales during 1914, and before that time, there is suggestion of a fresh strain of infection having been brought from Canada at the end of 1914 to this country by the first Canadian contingent which came to Salisbury Plain to undergo their final military training. It appears that cases had occurred among the Canadians in their camp at Valcartier before embarkation, and that other attacks among them were reported during the voyage to this country and just after their arrival. About 29 cases had been observed among the Canadian troops up to the middle of February and 25 of them had proved fatal. The predisposition to this infection may perhaps have been increased by the unavoidable overcrowding in camp which at first took place, as also by the occurrence of cold, wet and inclement weather, and by the unusual exertion and fatigue incidental to the military training of young recruits.

In a paper published by Dr. R. J. Reece,* one of the Board's Assistant Medical Officers, in the Journal of the Royal Army Medical Corps for June, 1915, a table is given showing the total cases of cerebro-spinal fever notified in the civil population of England and Wales, together with the number reported among the troops in the various commands during 1915, including cases in July. From this it appears that no fewer than 2,290 cases were notified in the civil population in that period and 1,088 among the

* The Journal of the Royal Army Medical Corps for June, 1915. Notes on the Prevalence of Cerebro-Spinal Fever among the Civil Population of England and Wales during the last four months of 1914 and the first six months of 1915; together with a short account of the Appearance of the Disease and of its Distribution among the Troops in the British Isles during the same Period, and of the Military Administrative Measures adopted to deal with the Prevalence of the Disease: By Surgeon-Colonel R. J. Reece, M.D. of the H.A.C., Second Assistant Medical Officer of the Local Government Board.

military, a total of 3,378 cases in 7 months. Precise details of the number of troops not being available, the incidence for a given number of soldiers cannot be stated. These figures are still being investigated at the time of writing, and are therefore liable to alteration and amendment when the examination is completed. The height of the prevalence in the civil population was reached in March and April, the highest number reported in any one week being 164 cases in the 7 days ended April 17th, and in the military the largest numbers occurred in the two weeks ended March 13th and 20th, when 87 and 86 cases respectively were recorded. Among the different commands, the largest number of cases occurred in the Southern District, where 300 attacks were reported, including cases among the Canadian contingent on Salisbury Plain. The Eastern Command came next with 244 cases, followed by Aldershot with 209 during the seven months. The smallest number of military cases, viz., 32, occurred in the Western Command.

Surgeon-General H. D. Rolleston reported that from August, 1914, to the end of July, 1915, 170 cases of cerebro-spinal fever had come under observation in the Royal Navy.

London.—The notification of cerebro-spinal fever in London was made compulsory in 1907, and the incidence there of the disease, as indicated by the number of notifications received and the deaths certified, is shown in the following table. The number of cases is compiled from the annual reports of the Medical Officer of Health for the County of London, and the deaths from the annual reports of the Registrar-General:—

Cerebro-spinal Fever in London.

Year.	Cases.	Deaths.
1907	135 (9 months only)	25
1908	85	35
1909	111	35
1910	115	30
1911	101	26
1912	105	25
1913	92	24
1914	73	15
1915	624*	—

In addition to the deaths certified in London from cerebro-spinal fever, others were recorded by the Registrar-General as due to posterior basal meningitis, namely, 72 in 1911, 39 in 1912 and 25 in 1913.

From the above table, assuming that the diagnosis, apart from bacteriological evidence, was correct in most cases, cerebro-spinal fever would seem to be endemic in London; but it has not tended to assume epidemic proportions during the last 8 or 9 years, though, coincidently with an increase in the rest of England, there was a marked rise in the number of cases notified in 1915.

* Of these, 185 occurred in the first quarter, 283 in the second, 95 in the third and 61 in the fourth quarter of 1915.

Scotland.

Notwithstanding the statement by Clemow and other writers on the subject that cerebro-spinal fever has appeared to be "almost, if not quite, unknown in Scotland," there is distinct evidence that outbreaks of cerebro-spinal fever have occurred in past years in different parts of Scotland. In 1877–78, for instance, some 34 cases came under the notice of Dr. T. J. Maclagan in Dundee, and Dr. Sinclair of the same town reported the occurrence of other cases in 1887. Dr. W. Frew, in 1884, described a series of cases of cerebro-spinal fever which had come under his care at Galston, Ayrshire, and in 1888 the same observer drew attention to the occurrence of the disease in various parts of Scotland. In the 13 years, 1883 to 1895, 73 deaths were medically certified as due to cerebro-spinal fever in Scotland. It is believed, however, by Dr. Frew and others who have made special investigations on this point, that the malady has been of more frequent occurrence in Scotland than these numbers would appear to show. It is very probable that other fatal cases of cerebro-spinal fever have in the past been certified, as elsewhere, under some other designation, such as inflammation of the brain, purpura, idiopathic tetanus or, perhaps, influenza.

From 1906 onwards the deaths attributed to cerebro-spinal fever have increased in number, and in that year a widespread epidemic developed in Scotland, reaching its height in 1907, the chief sufferer by which, as will be seen further on, being the city of Glasgow. The following table, compiled from the reports of the Registrar-General for Scotland, shows the number of deaths certified from cerebro-spinal fever from 1898 to 1915:—

Scotland.	1898	1899	1900	1901	1902	1903	1904	1905	1906
Deaths from cerebro-spinal fever.	2	4	2	5	2	2	2	2	301

Scotland.	1907	1908	1909	1910	1911	1912	1913	1914	1915
Deaths from cerebro-spinal fever.	1,732	445	154	39	85	68	66	60	321*

The serious epidemic which developed in 1906 did not altogether subside till the end of 1909, affecting chiefly Glasgow and certain towns in its vicinity; as well as the city of Edinburgh

* In addition to 192 deaths from cerebro-spinal fever during the first half of 1915, there were 538 others from simple meningitis, basal meningitis and meningitis the precise nature of which was not stated on the death certificate.

and the town of Leith with which Edinburgh is very closely associated. Of the total 1,732 deaths certified in Scotland during 1907, 715 were referred to Glasgow, and 47 to the adjacent towns of Govan, Motherwell, Paisley and Partick; 151 occurred in Edinburgh, 89 in Leith, and 32 in Dundee. The remaining 53 deaths were distributed among 7 other towns, viz., Coatbridge, Hamilton, Greenock and Kilmarnock in the west of Scotland; and Aberdeen, Perth and Kirkcaldy in the east.

Glasgow.—A single death from the disease was certified in Glasgow during 1901, but no others until 1906, when 166 were registered. The following table has been compiled as regards the notified cases of cerebro-spinal fever from the annual reports of the Medical Officer of Heath for the City of Glasgow, and, with respect to the deaths, from the reports of the Registrar-General for Scotland.

Table showing the number of cases of, and deaths from, cerebro-spinal fever in Glasgow from 1906 to 1915 inclusive:—

Cerebro-spinal Fever in Glasgow.

——	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915.
Cases ...	205	998	240	81	46	50	19	36	47	178
Deaths	166	715	159	48	32	46	21	30	33	117

Of the 998 notifications of cerebro-spinal fever during 1907, no fewer than 802, or a little over 80 per cent., were received during the first half of the year; and, with regard to the age distribution of the cases, almost 72 per cent. were under 10 years. According to the figures in the table, the case mortality rate in 1906 was 81·0 per cent., in 1907, 71·6, in 1908, 66·3. It is probable that in the early part of the epidemic many cases were not notified. Taking these 3 years together, the case mortality rate was over 72 per cent.; and for the whole 10 years' period 71·9.

Cerebro-spinal fever became compulsorily notifiable in Glasgow on August 10th, 1906. In a paper read, early in 1907, by Dr. A. K. Chalmers, the Medical Officer of Health for the city, before the Epidemiological Section of the Royal Society of Medicine, he mentioned that there was in 1906 an apparent increase in the number of deaths certified from tuberculous meningitis, and this he thought could be explained by assuming that some of these cases had been erroneously certified, and were, probably, fatal instances of cerebro-spinal fever. In a table appended to his paper he gave the deaths for each year, from 1901 to 1906, from (1) cerebro-spinal fever, (2) meningitis, inflammation of the brain, and (3) tuberculous meningitis. This table, extended to include the deaths from these three forms of meningitis up to the end of 1913, is given below.

The figures from 1907 onwards are taken from the annual reports of the Registrar-General for Scotland.

Table showing the deaths recorded from cerebro-spinal fever, meningitis, inflammation of the brain, and tuberculous meningitis, in the city of Glasgow from 1901 to 1913 inclusive:—

Deaths in Glasgow.	1901	1902	1903	1904	1905	1906	1907
1. Cerebro-spinal fever ...	1	...	...	...	...	166	715
2. Meningitis, inflammation of the brain.	438	414	411	388	363	329	102
3. Tuberculous meningitis ...	237	244	240	260	237	307	407
Deaths from all forms of meningitis	676	658	651	648	600	802	1,224

Deaths in Glasgow.	1908	1909	1910	1911	1912	1913
1. Cerebro-spinal fever	159	48	32	46	17	30
2. Meningitis, inflammation of the brain.	180	216	185	180	192	236
3. Tuberculous meningitis	309	296	273	253	240	307
Deaths from all forms of meningitis...	648	560	490	479	449	573

It is, therefore, probable, as suggested by Dr. Chalmers, that there has been some change in the certification of deaths from meningitis, and that, in all probability, deaths from cerebro-spinal fever in the years immediately prior to 1906 were certified under other forms of meningitis. There are good grounds, also, for believing that cerebro-spinal fever had been occurring practically unrecognised in Glasgow and other parts of the west of Scotland for some years before the epidemic of 1907. In this connection it is interesting to learn from Dr. Chalmers that Dr. Anderson, of Dennistoun, near Glasgow, had observed in his practice since 1891 a number of cases of meningitis, some of which were followed by paralytic sequelæ. In 1905, Dr. Chalmers himself had the opportunity of seeing several such instances with Dr. Anderson, and in that year some cases of the same nature were admitted to the Glasgow Fever Hospital from Port Glasgow, Partick and Whifflet. In 1904, cases of the same kind, it appears, had been recognised in Lanarkshire, and also at one of the health resorts situated on the Clyde. As has been said, there is every likelihood that cerebro-spinal fever had been occurring in the west of Scotland, practically unrecognised, and it was only when the serious epidemic was developing in Glasgow in 1906–7 that certification of deaths from the disease began to be more correctly made.

Edinburgh.—There were no deaths certified in the city of Edinburgh from cerebro-spinal fever in the 5 years' period, 1901 to 1905; but in 1906 there were 6 deaths attributed to this cause. In 1907 the notification of cerebro-spinal fever was made obli-

gatory in Edinburgh. The following table, compiled from figures given by Dr. Maxwell Williamson, the Medical Officer of Health, in his annual reports, shows the number of cases notified and deaths certified from cerebro-spinal fever in the City of Edinburgh from 1907 to 1915:—

——	1907	1908	1909	1910	1911	1912	1913	1914	1915	Total in 8 years
Cases ...	206	53	28	7	3	4	3	6	72	382
Deaths	135	23	16	4	3	4	2	2	44	233

Reckoned on the totals in the above table, the case mortality rate of cerebro-spinal fever in Edinburgh during the nine years' period was 61 per cent.

From the end of 1914 up to May, 1915, about 30 cases of cerebro-spinal fever occurred in Scotland among the military forces in various parts of the country. Cases of this kind were reported in the Edinburgh district, and at Glasgow, Galashiels, Aberdeen, Inverness, and elsewhere, but only in small numbers, mostly in single instances or in groups of two or three cases.

According to the returns of the Registrar-General for Scotland there were 64 deaths certified in Scotland from cerebro-spinal fever in the first quarter of 1915, and 128 during the second quarter, making, as previously stated, a total of 192 for the first half of 1915.

Ireland.

Cerebro-spinal fever has, apparently, been of more frequent occurrence in Ireland than in Great Britain. As far back as 1845–46 an outbreak occurred among the Royal Irish Constabulary at Dublin, and about the same time cases were also observed in the workhouse in that city as well as at Bray and Belfast. In 1850 the disease reappeared in Dublin, but it was not until 1866 that cerebro-spinal fever developed in epidemic form in Ireland; and it was then, owing to the appearance of purpuric patches on the skin, known under the names of "Black Death" or "Malignant Purpuric Fever." In that year 71 deaths were attributed to it in Dublin alone. Other fatal cases occurred in the adjacent districts of Tullamore, Rathcole and Clondalkin. There is also reason to believe that some deaths from cerebro-spinal fever were, during this epidemic, erroneously certified under other names. Cases of cerebro-spinal fever were reported in 1866 among the troops stationed in Ireland, as for example, in the barracks at Dublin and in the camp at Curragh. Other cases were recognised among the soldiers forming the flying column engaged in putting down the Fenian rebellion of that year. Staff-Surgeon Marston, of the Army Medical Department, reported 27 cases, of which 22 proved fatal. The disease continued to appear in Ireland from 1866 to 1869. At Dundalk, during the first three months of 1869, 23 attacks and 11 deaths were recorded, as well as 4 other deaths believed to be due to cerebro-spinal fever but certified under other names. In 1885–86 there was another epidemic of the disease at

Dublin, causing at least 52 deaths in 1885 and 28 in 1886. From 1885 to the beginning of 1887 there were 97 other deaths certified as due to " simple continued and ill-defined forms of fever," some of which may well have been cerebro-spinal. The acknowledged difficulties which often attend the diagnosis of this disease may account for the fluctuations which are observed during epidemic and inter-epidemic times in the certification of deaths from the different forms of meningitis. From the Annual Reports of the Registrar-General for Ireland the following table has been compiled, showing for a period of 24 years, 1891 to 1914, the number of deaths certified in Ireland from cerebro-spinal fever, simple meningitis, inflammation of the brain, and tuberculous meningitis.

Deaths from the various forms of Meningitis in Ireland.

Year.	Cerebro-spinal fever.	Simple meningitis, inflammation of the Brain.	Tuberculous meningitis.	Total all forms.
1891	...	...	824	...
1892	...	...	886	...
1893	...	...	885	...
1894	...	...	611	...
1895	...	...	1,159	...
1896	...	...	1,131	...
1897	...	...	1,158	...
1898	...	...	1,210	...
1899	45	443	1,242	1,730
1900	204	1.064	749	2,017
1901	88	1,073	661	1,822
1902	66	894	647	1,607
1903	37	882	748	1,667
1904	8	822	740	1,570
1905	32	838	710	1,580
1906	12*	736	797	1,545
1907	631*	699	866	2,196
1908	127*	760	826	1,713
1909	46	719	728	1,493
1910	14	692	701	1,407
1911	21	638	660	1,319
1912	23	631	637	1,291
1913	16	632	627	1,275
1914	16	592	609	1,217

The above table shows some remarkable variations in the number of simple meningitis deaths in particular years, and in those from tuberculous meningitis in others. There is suggestion, for example, that the excess of deaths certified from tuberculous meningitis during the five years 1895 to 1899 was due to some other cause, possibly epidemic cerebro-spinal meningitis; and the same remark might also apply to the sudden and remarkable rise

* In addition, 31 deaths in 1906, 43 in 1907 and 47 in 1908, were certified from "purpura." As purpuric eruptions are sometimes seen in epidemic cerebro-spinal meningitis, it is possible that some of these deaths may have been due to that disease and not to "purpura," which is, after all, a condition usually brought about by some other acute or infectious disease, and not to be, therefore, regarded in general as a separate entity.

in the number of deaths recorded from simple meningitis in 1900 and 1901, this probably being due to an epidemic of cerebro-spinal fever, and the deaths being certified incorrectly as simple meningitis.

Of the 631 deaths certified in Ireland during 1907 as due to cerebro-spinal fever, 358 were males and 273 females; and, as regards the distribution in age groups, 418, or 66·2 per cent., were under ten years of age, and 280, or 44·4 per cent., were under five.

The chief sufferer from the epidemic in 1907 in Ireland was the Borough of Belfast, in which, during the 52 weeks ended December 28th, there were notified 623 attacks, 495 of them terminating fatally, giving a case mortality rate of 79·4 per cent.

The epidemic in Belfast followed the course usually observed elsewhere, expending its violence mostly during the winter and spring months. The incidence of the disease in each quarter of 1907 is shown in the following table:—

Cerebro-spinal Fever in Belfast.

1907.	Notified Cases.	Deaths.
1st Quarter	233	154
2nd ,, ...	291	242
3rd ,, ...	54	70
4th ,, ...	45	29
Total	623	495

The epidemic continued in a modified way in Belfast during 1908, 61 fatal cases being recorded there, out of the total 127 deaths certified in the whole of Ireland from this cause during the year.

The precise origin of this outbreak is not clear; whether it was due to an accession of virulence in an endemic strain of the meningo-coccus, or to the importation of a fresh variety of the virus from America or elsewhere abroad, cannot be now decided. It is noteworthy, however, that Belfast and Glasgow suffered at the same time from epidemics of cerebro-spinal fever. These two ports are in frequent and close relation with each other by shipping, and both of them have intimate association commercially with the larger ports of the United States where cerebro-spinal fever is of common occurrence. During the 1907 epidemic in Ireland 43 deaths from the disease were recorded in the Dublin district and 13 in Lurgan. Among other localities in which fatal cerebro-spinal fever cases came under notice were Newtownards. Cork and Larne, but not in any great amount. Reference to the table on page 128 shows that, after 1909, the incidence of cerebro-spinal fever in Ireland, as judged by the number of deaths attributed to it in the Registrar-General's Annual Reports, gradually diminished, as indeed did the number of deaths from the other forms of meningitis, the year 1914 showing the smallest number of deaths from all forms of meningitis, of all the 24 years given in the table.

Early in 1915, cases began to be notified in Ireland in more than usual amount. Dr. G. E. Nesbitt, acting as Sanitary Officer for the Troops in the Dublin District, in an article published in the "Dublin Journal of Science" for May, 1915, states that 89 cases of cerebro-spinal fever were notified in Ireland from the end of January to May. He had notes of 15 cases with eight deaths among the troops in the Dublin district; and he had been informed on good authority that cases were also occurring in the neighbourhood among the civil population. So far as can be learned, the first observed case in this new prevalence in Ireland was detected at Kildare on the last day of November, 1914, in a man who had passed through Woolwich a fortnight previously, where it was inferred he had contracted the infection. The second case was notified at Mullingar, but did not occur until two months after the first, and soon afterwards a third instance came under observation at the Curragh Camp. It has been surmised that a new strain of infection had been brought to Ireland from Woolwich and had spread in the usual way, showing a tendency to attack specially the troops in camps and barracks. Later, other cases were reported in the Dublin district, Randalstown, Longford, Clandeboye, Tipperary, Lurgan, Galway, Carrickfergus, and in the military camp at Ballykinlar. From the Registrar-General's report for the second quarter of 1915, it appears that 14 deaths from cerebro-spinal fever were registered, and that cases had been notified from 13 districts.

From December, 1914, to April 10th, 1915, 50 cases, ten of which were fatal, occurred in Belfast; 47 of these cases were isolated in Purdysburn Municipal Fever Hospital. From May to October, 30 more cases were reported.

France.

Cerebro-spinal fever has long been present in France, appearing generally in sporadic form. Occasionally there have occurred localised epidemics which have, however, in no instance attained such great proportions as those which have been observed of recent years, for example, in Germany and Austria, details of which will be found further on. The disease was prevalent in France during 1885–86, when, among other places, it was observed at Rochfort, a seaport, arsenal and fortress of the first class in the western department of Charente Inférieure. Cerebro-spinal fever was again prevalent in various parts of France in 1898, 1900, 1905 and 1909. M. Leon Colin, in 1905, drew attention to the fact that in France several competent observers had come to the conclusion that epidemic cerebro-spinal meningitis had a close connection with prevalence of influenza. In a discussion on the subject in the French Académie de Médecine, Dr. E. Boiret in 1909 drew attention to the fact that recrudescence of epidemic cerebro-spinal meningitis usually occurred after a period of intensely cold weather, and that it was accompanied often by the prevalence of an influenza-like illness. He also expressed the opinion that the disease was endemic in the

south-east of France. It has been observed that cerebro-spinal fever often occurs among the French troops in various garrison towns. Netter and Debré* in their work have drawn attention to this, and from their pages the following table has been compiled, showing, year by year, from 1898 to 1908, the number of cases and deaths reported from cerebro-spinal fever in the French Army of the Interior; also the cases and deaths recorded from "simple meningitis," and the deaths from tuberculous meningitis:—

Year.	Cerebro-spinal fever.		Simple meningitis.		Tuberculous meningitis.
	Cases.	Deaths.	Cases.	Deaths.	Deaths.
1898 ...	25	14	+	32	109
1899 ...	28	20	+	40	87
1900 ...	48	28	+	55	103
1901 ...	42	28	66	41	109
1902 ...	48	33	62	40	87
1903 ...	46	24	46	32	76
1904 ...	33	20	38	33	69
1905 ...	77	47	39	37	84
1906 ...	111	57	40	39	77
1907 ...	108	39	51	26	108
1908 ...	111	59	72	46	112
Total in 11 years.	677	369	414†	421	1,021

The marked increase in the number of deaths from tuberculous meningitis during 1907–8, when cases of cerebro-spinal fever had been recorded in greater amount in the army, suggests the possibility that some at least of these increased deaths were due to the prevalent meningo-coccal infection. The same remark might, perhaps, be applied to some of the cases and deaths ascribed to "simple meningitis." It is somewhat difficult to follow the occurrence of cerebro-spinal fever among the civil population of France. The annual official statistical reports, "Statistique Sanitaire des Villes de France," which the Local Government Board formerly received year by year, ceased to come to hand after 1905; but none of these contained any mention at all of epidemic cerebro-spinal meningitis. Probably, deaths attributed to it were included under the heading "Autres maladies épidémiques," or in error under "simple meningitis" or "tuberculous meningitis." Moreover, these death-returns relate only to those towns which have a population of more than 5,000 inhabitants, and apparently do not include statistics of the rural districts or the smaller towns.

* La Méningite Cérébro-spinale, Paris, 1911.

† Eight years only.

Deaths from meningitis, 1896 *to* 1905, *in French Towns having a population over* 5,000.

Year.	Simple meningitis.	Tuberculous meningitis.	Total deaths from meningitis.
1896	6,531	3,884	10,415
1897	6,470	3,936	10,406
1898	6,896	3,732	10,628
1899	7,117	3,670	10,787
1900	7,275	3,840	11,115
1901	7,400	3,438	10,838
1902	7,529	3,683	11,212
1903	7,194	3,651	10,845
1904	7,336	3,601	10,937
1905	7,165	3,527	10,692
Total in 10 years.	70,913	36,962	107,875

In 1905, the disease was reported as present in Périgueux, 95 miles from Bordeaux, and at Nice, in each instance among both the military and the civil population.

From 1889 to 1912 cerebro-spinal fever was appearing in Paris, but not to any great extent except in 1909 and 1910.

Notification of cerebro-spinal fever became compulsory in Paris during 1903. The following table, compiled from the *Annuaire Statistique de la Ville de Paris,* gives the number of cases of the disease notified in the city and in the suburbs from 1906 to 1912 inclusive:—

Year.	City of Paris.	Suburban communes.	Total.
1906	4	5	9
1907	5	4	9
1908	16	4	20
1909	260	108	368
1910	119	59	178
1911	94	49	143
1912	68	37	105
Total in 7 years.	566	266	832

From 1905 to 1910 cases were reported among the troops of the garrison and among the civil population of Poitiers, the capital of the Department of Vienne, 60 miles south-west of Tours, in which town also cases had been reported in each year from 1905 to 1909. During the first quarter of 1909, 139 attacks of cerebro-spinal fever with 33 deaths were reported among the French troops in 45 different places, mostly in small groups of cases. During these three months, there were 19 cases among the garrison of Evreux, the capital of the Department of Eure, about 67 miles from Paris; 19 at Rennes in Brittany, 51 miles from

St. Malo; 18 at St. Mihiel in the valley of the Meuse; and 13 at Verdun, 35 miles from Metz.

The outbreak among the military at Evreux was accompanied by a prevalence of the disease among the civil population in the town, and in the adjoining department of La Manche and Calvados, in Normandy. This prevalence began in the autumn of 1908. The strain of infection seems to have been of a more than usually virulent type, and some of the attacks were of the fulminant kind, death taking place within 24 hours of the onset of the disease and sometimes before a definite diagnosis could be made. The occurrence of other cases with the characteristic features of cerebro-spinal fever soon removed all doubt as to the true nature of the current malady. The development of the Evreux epidemic followed upon a spell of extremely cold weather, a point to which French authorities, as has been said, attach some importance, and it occurred at a time when an influenza-like illness was very rife in the neighbourhood. The garrison at Evreux comprises two regiments, one of cavalry and one of infantry.

A report on the outbreak was made to the Académie de Médecine by Dr. Vaillard,* who stated that at the end of December, 1908, a cavalry soldier of the Evreux garrison died somewhat suddenly of what was afterwards recognised to be a fulminant attack of cerebro-spinal fever. Early in January, 1909, a detachment of reservists, 122 in number, joined the cavalry regiment for 21 days' training, and, after their departure, a second party numbering 106 joined the regiment for a like period, occupying the quarters just vacated by the first detachment. The first of the cavalrymen to be attacked died on January 13th, and 21 days later two other men of the same regiment died also from the disease, one of them only 15 hours after the onset of his illness. By February 15th, nineteen cases had been reported, all among men belonging to the same cavalry regiment, and eight of them were reservists serving temporarily with the dragoons. Four of the patients occupied the same room, three of them sleeping in adjoining beds. In a second room, two men occupying adjacent beds were attacked. One of the attendants on the sick also contracted the disease. Cases began to occur among the civil population about this time; one was a young girl of 15 who had visited her brother-in-law, a reservist at the barracks, who died of this malady. Another civil case was a young man who was an habitual visitor at a café frequented by the cavalrymen; while a third person attacked was the coffee-house keeper himself. In addition to the 19 attacks among the cavalry, several reservists were attacked by the disease on their return home after completing their period of training, and in several instances they conveyed the infection to their own and other families. Dr. Vaillard gives details of such cases, and, as they are of interest, some of them may be quoted:—

1. A reservist returning to his home at some distance from Evreux infected three persons, namely, his two children and his aged father, the last-named succumbing to the attack.

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* "Sur la méningite cérébro-spinale"; séance du 27 Avril, 1909.

2. A reservist, on reaching his home in the Department of Calvados, almost immediately fell ill, his illness lasting several days. About a week after his arrival, a young servant girl employed by the family developed the characteristic symptoms of cerebro-spinal fever, and died after two days. A youth who often visited the family fell ill a week after the girl died, but he recovered. The reservist's wife was attacked about the same date and died within 24 hours, her main symptoms being rigidity of the neck and a confluent eruption. One of the servants working on the reservist's farm contracted the disease, but recovered. Excluding the reservist himself, there were thus four cases and two deaths resulting from the infection which he brought with him from Evreux. Some fifteen days later, when the above facts were reported, this man was examined by a bacteriologist, who found the meningo-coccus in abundance in his naso-pharynx.

3. A reservist, a farm servant, on completion of his period of training, returned to the farm where he was employed. Feeling ill during the next few days he went to his brother's cottage in the neighbourhood. He remained there five nights, sleeping with the other members of his brother's family in the same room. As soon as he had returned to work, the brother's wife and one of their five children were attacked by "meningitis," and were visited by another relative who was also attacked by the same disease; all three, however, recovered. At the farm to which the reservist returned to work, the farmer's wife and infant daughter fell ill and died of cerebro-spinal meningitis. Thus, this reservist caused, within a short period, five cases and two deaths in the two households in which he had lived after his return from Evreux. His naso-pharynx was bacteriologically examined shortly afterwards, and he was found to be harbouring the meningo-coccus in large amount.

4. A reservist returned from Evreux to his home in the Department of Eure, and, some days later, his wife was attacked by cerebro-spinal fever of which she died.

5. The child of a corporal-farrier of the dragoon regiment at Evreux fell ill with cerebro-spinal fever. Her father had one of the cavalrymen to assist him in his work, and this man was attacked by cerebro-spinal fever. The meningo-coccus was found in the nasal discharges of the corporal, who was recognised as a carrier of the disease.

In the civil population of the town of Evreux, 48 cases were reported from January to March, 1909, and 20 had a fatal termination. It is stated that no fewer than 72 persons were found in Evreux to be carrying the meningo-coccus in their naso-pharynx.

In January, 1912, an outbreak of cerebro-spinal fever occurred at La Flèche, a small sub-prefecture in the Department of Sarthe, having a population of about 10,000 and a garrison of 400. The first case was a soldier who had been visiting his friends at Laval, the capital of the Department of Mayenne, 46 miles from Rennes. The disease had been prevalent in Laval, where 95 cases and 11 deaths had occurred in 1911. Four other cases occurred at La Flèche among the comrades of the first

patient. The total number of cases and deaths in this outbreak has not been given, but it is stated that among the contacts 25 persons were found to be carriers of the infection.

In a paper presented on July 27th, 1915, to the Académie de Médecine, by MM. Sacquépée, Burnet and Weissenbach, the question of acute meningitis among the troops in the field was discussed and the results of post-mortem and bacteriological examinations of 121 cases were given; 62 of these instances, or about 50 per cent., yielded the meningo-coccus, while, in the remaining 59, other organisms were found to be the cause of the meningitis. Before the war, the proportion of military cases of meningitis in which the meningo-coccus was found was over 90 per cent. The proportion of carriers found recently among the contacts in the field was only about 1·33 per cent., compared with from 4 to 5 per cent. before the war. This difference, it is suggested, is due to the open-air life led by the troops in the field, the men rarely being concentrated under conditions of confined space. Of six cases of meningitis in one regiment, two were found to be due to the meningo-coccus, two to the pneumo-coccus and two to the strepto-coccus. There would be, it is remarked, a predisposition to meningitis during war time, following upon fatigue, want of sleep, and the effects on the cerebro-spinal system of the continuous concussion of explosives, as well as in view of the nervous tension of the soldiers in the trenches exposed to bombardment at all hours.*

Towards the end of 1913, cerebro-spinal fever broke out among the garrison of St. Lô, in the Department of La Manche, and at Brest, appearing in November at the former place and in December at the latter. At St. Lô, five cases, one of which was fatal, were reported, among the soldiers; in addition, nineteen carriers of the meningo-coccus were detected among contacts. At Brest, two cases were fatal within 48 hours of the onset of illness.

The Low Countries.

Holland.—It is stated by most writers on the subject that cerebro-spinal fever has been comparatively rare in Holland. In recent years sporadic cases have been reported, but there have been no epidemics. So far as can be ascertained, there were 121 cases and 52 deaths in Holland from 1905 to 1911 distributed as follows:—

Year.	Cases.	Deaths.
1905...	3	1
1906...	16	6
1907...	41	18
1908...	29	10
1909...	20	11
1910...	9	5
1911...	3	1
Total in 7 years	121	52

The number of reported cases in 1912 has not been ascertained, but in that year 12 fatal cases were recorded. During 1913 some

* Bulletin de l'Académie de Médecine, July 27th, 1915.

cases occurred in Rotterdam, Amsterdam and elsewhere; two deaths were reported at Amsterdam, where also in the early part of 1915 two cases and one death were recorded.

In the Annual Report of the Municipality of Amsterdam* for 1914 a table is given showing the number of deaths from different forms of meningitis for the 13 years 1902 to 1914. This table, with some additions, is appended:—

Municipality of Amsterdam [Population (1911), 580,960].

Deaths from meningitis of all forms, 1902 *to* 1914.

Year.	Tuberculous meningitis.	Simple meningitis.	Epidemic cerebro-spinal meningitis.	Total deaths from meningitis.	Death rates from all forms of meningitis per 100,000 of the population.
1902 ...	143	202	1	346	64·2
1903 ...	156	200	...	356	65·1
1904 ...	136	220	3	359	65·1
1905 ...	104	197	1	302	54·1
1906 ...	146	126	2	274	48·6
1907 ...	142	118	1	261	46·1
1908 ...	111	92	...	203	35·9
1909 ...	161	107	3	271	47·9
1910 ...	133	89	...	222	38·7
1911 ...	146	79	...	225	38·7
1912 ...	142	77	...	219	37·5
1913 ...	145	74	2	221	37·4
1914 ...	128	80	...	208	33·7
13 years ..	1,793	1,661	13	3,467	47·2

During March and April, 1915, an outbreak occurred among the infantry of the garrison at Amersfoort, 14 miles from Utrecht. On investigation it was found that out of 50 men housed in one building 16 were harbouring the meningo-coccus in the naso-pharynx. No cases occurred at the time in the civil population. The precise number of cases among the military is not stated.

Belgium.—Cerebro-spinal fever has also been comparatively rare in Belgium, but in the three years 1910–12 103 cases were recorded, namely, 37 in 1910, 36 in 1911, and 30 in 1912. Some of these cases occurred in Brussels, but the precise number has not been stated. During 1913, 43 cases were officially reported to the authorities, of which 11 were referred to the province of Brabant, 16 to Eastern Flanders, 8 to Western Flanders, 4 to Liége, and 2 each to the provinces of Limburg and Hainault. In the first half of 1914 a few cases occurred at Enghien, in Hainault, but since the commencement of the war no information as to the incidence of the disease in Belgium has reached this country.

* Verslag van den Toestand der Gemeente Amsterdam Gedurende het Jaar 1914.

Luxemburg.—A few sporadic cases have come under observation in the Grand Duchy of Luxemburg during the nine years ended December 31st, 1912, amounting in all to about seven, three of which were reported in 1906. During 1913 the disease appeared at Berg, not very far from Grevenmacher, which is close to the German frontier.

SCANDINAVIA.

Denmark.—According to Hirsch, the amount of epidemic cerebro-spinal meningitis observed in Denmark from 1848 to 1886 had been inconsiderable. In the period 1845 to 1848, however, Denmark was the only country in Europe in which the disease was prevalent to any considerable extent. In 1873–4 there was an epidemic in Jutland. In the period 1888 to 1898 the number of officially reported cases was as follows:—

Denmark—Cerebro-spinal fever cases.

1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	Total.
38	47	50	85	141	127	49	28	66	98	245	974

The average number of reported cases during this eleven years' period was about 88 annually.

In all the more recent years cases of the disease have occurred in Denmark, though no epidemics on a large scale have been observed. It is, however, probable that in Denmark, as in other countries, some cases of this disease remain unrecognised. From 1899 to 1913 the following cases and deaths were recorded*:—

Cerebro-spinal fever in Denmark.

——	1899	1900	1901	1902	1903	1904	1905	1906
Cases ...	130	168	125	91	74	68	64	61
Deaths ...	38	39	25	19	16	10	9	6

——	1907	1908	1909	1910	1911	1912	1913	1914	Total.
Cases ...	51	66	125	83	56	41	49	49	1,301
Deaths ...	7	7	47	26	17	12	†	†	†

It appears from the preceding table that upon an average there were rather more than 81 cases reported annually during the period. The population of Denmark in 1911 (not including Iceland and Greenland, etc.) was 2,775,076.

* These figures have been compiled from the Annual Reports; the cases from "Medicinalberetning for den Danske Stat," and the deaths from "Dodsaarsagerne I Kongeriget Danmarks Byer."

† Figures not available.

The chief place in Denmark in which cerebro-spinal fever has maintained an almost continuous prevalence during recent years is Copenhagen, the capital, which, including the suburbs, had a population of about 560,000 in 1911.

The following table gives the number of cases and deaths reported from cerebro-spinal fever in that city from 1886 to 1914:—

——	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
Cases	176	27	15	9	25	44	44	44	12	16	36	34	161	61	26
Deaths ...	80	24	9	—	10	34	25	22	4	9	19	13	83	28	10

——	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	Total in 29 years.
Cases ...	19	20	10	9	10	7	6	10	71	37	23	11	11	8	982*
Deaths ...	12	10	7	5	4	1	1	5	37	20	14	6	7	6	505*

Calculated upon the above figures, the case mortality rate in Copenhagen for the whole period was 51·4 per cent.

During 1914, 49 cases were reported in Denmark, eight of them being in Copenhagen; in 1915, up to November, the figures were 62 and 12 respectively.

Norway.—This country has, to a large extent, escaped the ravages of epidemic cerebro-spinal meningitis in the past. The disease has mostly appeared there only in sporadic form. Netter states, however, that from 1866 to 1882 the incidence of the malady in Norway increased, and that during those years 967 cases came under observation, an annual average of nearly 57. In 1887 there were 120 cases, with 43 deaths in Norway. From 1890 to 1894 inclusive, the recorded cases and deaths amounted respectively to 167 and 61, distributed as follows:—

Cerebro-spinal fever in Norway.

——	1890	1891	1892	1893	1894	Total.
Cases	31	14	55	34	33	167
Deaths	9	6	28	11	7	61

From 1901 to 1905 there were officially reported† 260 cases and 111 deaths, distributed as follows:—

——	1901	1902	1903	1904	1905	Total.
Cases	93	39	32	19	77	260
Deaths	35	20	11	7	38	111

* These figures have been taken from the Annual Reports ("Stadslaegens Aarsberetning") for each of the years in question.

† Sundhetstilstanden og Medicinalforholdens.

During 1906, 11 cases were recorded, in 1907, 31, and in 1908, 24. In 1912 the disease was more prevalent in Norway* than in any previous year, 364 cases and 198 deaths being recorded; 200 of these attacks and 135 of the deaths occurred in Christiania, the capital.

In 1913 the total cases notified in Norway numbered 47 and the deaths 26; and in 1914 40 cases and 15 deaths. In the first half of 1915 only eight cases, with two deaths, were recorded in the whole of Norway.

Christiania [population (1910), 241,834.]—The capital of Norway has suffered little, apparently, in the past from the ravages of cerebro-spinal fever. From 1866 to 1910 only ten cases seem to have been reported. In 1911 eight cases came under observation, but in 1912 the disease became very prevalent, 200 cases and 135 deaths being recorded. In 1913 there were 38 cases and 24 deaths; in 1914 only 15 cases and 4 deaths; and in the first half of 1915 seven cases and two deaths. During the prevalence of cerebro-spinal fever in Christiania in 1912 attempts were made to discover if the infection was being spread by "healthy carriers." Accordingly, no fewer than 797 swabs were taken for bacteriological examination from the nasal passages of suspected persons who had come into contact with infected individuals, but with only four positive results.† This is very different from what was found in the severe Silesian epidemic of 1905 and in other German outbreaks, as will be seen later, where the spread of the disease by carriers was clearly demonstrated.

Sweden.—Since 1854 cerebro-spinal fever has been present in Sweden, but of late years it has diminished in amount. The disease first appeared, in 1854, at Gothenburg, which, next to Stockholm, is the most important town in Sweden; afterwards it spread over the rest of the country. The epidemic continued up to 1861, and its course may be seen in the following table which is compiled from the figures given in Netter and Debré's work‡:—

Year.	Cases.	Deaths.	Provinces. invaded.	Communes attacked.
1855	3,000	886	6	35
1856	2,000	428	9	44
1857	3,051	1,387	16	157
1858	1,909	779	19	115
1859	1,415	582	18	77
1860	347	148	12	32
1861	91	27	9	11
Total ...	11,813	4,237	...	...

The epidemic lasted about seven years, and, reckoned on the above figures, the case-mortality rate was 35·9 per cent., a comparatively low rate for cerebro-spinal fever. It appears that the disease, though appearing in each of these years, subsided almost

* The population of Norway in 1911 was 2,392,698.

† Usvedt & Diesen, in the Centralblatt für Bakteriologie und Parasitenkunde Originale, lxxii.

‡ La Méningite Cérébro-spinale, 1911.

altogether every summer, becoming epidemic again in the colder months. Since 1861 the disease has never been entirely absent from the country, though of late years, as has been said, the amount of it has been less than formerly. During the ten years ended 1886 the total cases of cerebro-spinal fever in Sweden amounted to 796 or an annual average of about 80; but 112 cases were reported in 1887, and 117 in 1888. From this time the disease began to increase, as may be seen in the following table. The average yearly number of cases during the ten years' period was 184.

Table giving the number of cases and deaths from cerebro-spinal fever in Sweden in the ten years 1889 to 1898:—

—	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
Cases ...	196	605	227	102	111	122	96	165	118	98
Deaths .	*	227	136	60	61	55	59	74	82	50

Taking the nine years, 1890 to 1898, for which the number of attacks and deaths is known, there were altogether 1,644 of the former and 804 of the latter, giving a case-mortality rate, for that period, of 48·9 per cent.

In more recent years, though fatal cases of cerebro-spinal fever have appeared regularly in the annual mortality returns, there have been no epidemics. In 1903 epidemic polio-myelitis first appeared in the Swedish death returns, and, as it is known that this disease existed in Sweden prior to that year, it is not unlikely that epidemic polio-myelitis and cerebro-spinal fever may have been confused and deaths from one or the other wrongly recorded, and, perhaps, in this way the number of reported fatal cases of cerebro-spinal fever has been increased. From 1903 to 1910 only 270 deaths were attributed in Sweden to cerebro-spinal fever and 449 to epidemic polio-myelitis. The subjoined table shows the number of deaths from cerebro-spinal fever during each year from 1903 to 1910†:—

——	1903	1904	1905	1906	1907	1908	1909	1910
Deaths	28	21	40	26	21	121	33	29

In 1909, some 52 cases of cerebro-spinal fever were officially reported, and, in 1910, no fewer than 611.‡

The population of Sweden in 1910 was 5,522,403. There is at present no official information available to show the incidence of cerebro-spinal fever in Sweden during 1911, 1912, 1913 and 1914.

* Mortality returns for 1889 not obtained.

† These figures are taken from the Official "Bidrag till Sveriges Officiella Statistik för 1910."

‡ Veröffentlichungen des Kaiserlichen Gesundheitsamtes, 1913, page 1051. It is possible that the number of deaths for 1910 is understated in the table above, that is, if, as reported, the cases were as many as 611.

It is, however, known that the disease was present in Stockholm in 1911 and 1913, and again in 1914, though the precise number of cases and deaths has not been obtained.

During the first half of 1915, 12 cases and 6 deaths were recorded in Stockholm.

Germany.

Cerebro-spinal fever has been for a considerable time endemic in Germany, giving rise frequently to localised outbreaks and occasionally to serious epidemics. It sometimes becomes prevalent among the troops in barracks and among the inmates of prisons, workhouses and similar institutions. One of the most serious German epidemics of cerebro-spinal fever was that which occured in the Valley of the Vistula in the winter of 1864-65, and which has been already well described by Burdon-Sanderson, Hirsch and others. In that epidemic nearly 2,000 persons were attacked, and more than 1,000 of them died. The largest number of attacks occurred in persons under the age of 15.

The following table presents shortly a view of the fatal incidence of the disease in Germany in recent years, namely, from 1892 to 1913. The figures have been taken chiefly from the annual statistical reports, *Ergebnisse der Todesursachenstatistik*, published in the yearly *Medizinal Statistiche Mitteilungen aus dem Kaiserlichen Gesundheitsamte*, and from the reports of Geheimer-Regierungsrat Dr. Rahts.

Deaths from cerebro-spinal fever in Germany, and in certain of the individual German States.

Year.	Germany.	Prussia.	Bavaria.	Saxony.*	Württemberg	Baden.*	Hesse.
1892 ...	317	204	91	+	+	3	26
1893 ...	368	237	111	+	+	+	+
1894 ...	459	241	139	+	+	19	40
1895 ...	380	258	58	+	15	19	4
1896 ...	585	447	63	+	13	6	8
1897 ...	564	358	97	+	9	25	16
1898 ...	400	283	66	+	3	16	6
1899 ...	353	250	49	+	6	12	2
1900 ...	342	224	57	+	9	6	14
1901 ...	341	225	52	+	10	6	3
1902 ...	350	242	59	+	9	7	5
1903 ...	226	163	52	+	9	6	7
1904 ...	266	142	71	4	13	1	3
1905 ...	2,715	2,521	120	8	8	7	6
1906 ...	1,391	1,275	63	18	7	7	5
1907 ...	1,769	1,613	89	19	4	13	8
1908 ...	879	758	39	19	5	9	1
1909 ...	707	499	43	11	+	+	+
1910 ...	317	194	32	—	+	+	+
1911 ...	+	111	38	3	+	+	+
1912 ...	+	157	29	+	+	2	1
1913 ...	+	+	18	+	+	+	+

+ Information for these years not available.

* The information regarding the kingdom of Saxony and the Grand Duchy of Baden is fragmentary, their statistical tables classing, apparently, cerebro-spinal fever among "other infections."

It is obvious from this table that cerebro-spinal fever has not been absent from Germany during the last 20 years or more, and that the chief sufferer from the disease has been Prussia, which, roughly speaking, had, in 1911, a population of about 40 millions out of the total 72 millions comprised in Germany at that date. Among certain other German States not included in the preceding table, cerebro-spinal fever has also occurred year by year, though not in great amount, namely in the Grand Duchy of Mecklenburg-Schwerin, the provinces of Alsace-Lorraine and Brunswick, as well as in the free cities of Hamburg and Bremen. Scattered cases have occasionally been reported during the last 20 years in certain other German States, including Saxe-Weimar, Mecklenburg-Strelitz, Oldenburg, Saxe-Meiningen, Saxe-Coburg-Gotha, Lippe, Anhalt, Waldeck, and the free city of Lübeck. As the numbers are comparatively small in the last group they have not been included in the following table, which gives the number of deaths recorded from cerebro-spinal fever in certain German States from 1892 to 1913* :—

Year.	Mecklenburg-Schwerin.	Brunswick.	Alsace-Lorraine.	Hamburg.	Bremen.
1892 ...	—	2	18	3	1
1893 ...	—	—	11	6	3
1894 ...	—	13	19	6	1
1895 ...	—	8	15	21	1
1896 ...	—	6	18	26	3
1897 ...	26	8	34	11	3
1898 ...	2	8	19	9	3
1899 ...	2	3	30	6	6
1900 ...	—	5	24	8	1
1901 ...	—	4	38	8	1
1902 ...	—	—	30	3	—
1903 ...	1	2	32	8	2
1904 ...	—	4	16	6	2
1905 ...	1	4	15	9	1
1906 ...	—	2	11	3	—
1907 ...	6	—	12	68	2
1908 ...	5	—	19	16	1
1909 ...	—	—	—	7	3
1910 ...	—	—	—	7	1
1911 ...	—	—	—	4	1
1912 ...	—	—	—	3	—
1913 ...	—	—	—	2	—

Prussia.—As has already been said, Prussia has been the chief sufferer among the German States from the incidence of cerebro-spinal fever during the last 25 years. In the subjoined table is given the distribution of the fatal cases of the disease during the 10 years 1892 to 1901 in each of the provinces now included in the kingdom of Prussia. It will be seen that 2,727 deaths were recorded from this cause in that period, the province which suffered most being Prussian Silesia, which borders on Russia and Austria, and which is one of the most productive coal-mining

* This Table is incomplete, but it gives all the information obtainable from the various sources which were available at the time of writing.

regions of Germany. Cerebro-spinal fever practically has never been absent from this province since about 1876, and, as will be seen further on, Silesia was ravaged by a very severe epidemic of the disease in 1905. During the 10 years 1892 to 1901, 502 deaths from cerebro-spinal fever were reported in Silesia, the provinces coming next being the Rhine Province with 293 deaths, and Brandenburg, including Berlin, with 288. Except in the small province of Hohenzollern, deaths from cerebro-spinal fever were recorded for every one of the 10 years in all of the Prussian provinces.

Table showing number of deaths recorded from cerebro-spinal fever in each of the Provinces of Prussia from 1892 *to* 1901.

——	Population 1900.	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	Total in 10 years.
East Prussia ...	1,996,626	26	23	19	21	17	16	27	19	24	21	213
West Prussia ...	1,563,658	19	23	24	14	21	22	11	40	17	15	206
Brandenburg, including Berlin.	4,997,402	21	22	18	24	75	33	23	24	23	25	288
Pomerania ...	1,634,832	11	19	15	26	33	13	13	9	12	11	162
Posen	1,887,275	6	10	11	13	22	13	7	7	12	11	112
Prussian Silesia ...	4,668,857	27	30	40	52	93	94	67	45	27	27	502
Prussian Saxony ...	2,832,616	20	28	17	29	37	23	21	18	19	19	231
Schleswig-Holstein	1,387,968	6	7	10	7	11	5	7	7	9	8	77
Hannover ...	2,590,939	14	26	23	31	37	37	26	12	22	25	253
Westphalia ...	3,187,777	23	13	19	9	40	59	29	19	18	24	253
Rhine Province ...	5,759,798	24	24	22	16	34	34	40	38	31	30	293
Hesse-Nassau ...	1,897,981	7	12	21	13	24	8	12	10	9	9	125
Hohenzollern ...	66,780	—	—	2	3	3	1	—	2	1	—	12
Prussia	34,472,509	204	237	241	258	447	358	283	250	224	225	2,727

During 1902, the total deaths from cerebro-spinal fever were 242; in 1903, the number had fallen to 165; and, in 1904, to 142. Towards the end of November, 1904, cases began to be recorded in Upper Silesia in the industrial town of Königshutte, about 110 miles from Breslau, and in Neu Heiduk, situated in the neighbouring mining district of Beuthen, as also in the iron district of Tarnowitz—all in the populous industrial administrative district of Oppeln. During December the cases became more numerous, and, up to March 31st, 1905, 1,065 attacks and 568 deaths had been reported. It is noteworthy that 903 of the cases, or 84·8 per cent. of the total, were under the age of 15 years. Up to the end of 1905 the total number of recorded attacks in Prussian Silesia amounted to 3,317, out of a total of 3,764 (2,521 fatal) in the whole of Prussia. The serious epidemic of 1905 in Prussian Silesia was almost limited to the already mentioned administrative district (Regierungsbezirk) of Oppeln, which had then a population of 1,862,562, and in which, during 1905, no fewer than 3,149 cases were reported out of the total 3,317 observed in the whole province during the year. It is worth mentioning that of the total cases notified during 1905, 83·7 per cent. were under the age of 15 years. The case mortality rate at all ages was 67·2 per cent. Most of the deaths occurred during the first week of the patient's illness, but among the cases which

recovered there were persons who had lost the sight of one or both eyes; some had a squint, and some others had various defects of vision not amounting to total blindness. There were instances in which the patients were left totally deaf in one or both ears, and, in other cases, the hearing was impaired, though not totally destroyed. Some recovered with paralysis, complete or partial, of one or other of their limbs, and in a few cases mental deficiency resulted from the illness, amounting in some instances to imbecility. Seldom was more than one attack observed in the same house, notwithstanding the fact that the workmen in the Oppeln district are remarkable for the largeness of their families, there being thus a tendency to over-crowding of dwellings, which facilitates the spread of infection. The largest proportion of the cases was recorded during the spring months, and the smallest in the autumn. The existence of carriers of the infection was demonstrated, and, in many cases where the test was applied, the nasal discharges of those in close relation with the sick yielded the meningo-coccus for a time. In 1,186 patients, whose cases were bacteriologically studied, 1,050 showed the presence of the diplo-coccus intra-cellularis of Weichselbaum, mostly in the cerebro-spinal fluid; but in 136 instances the presence of other pathogenic organisms, including pneumo-cocci, staphylo-cocci and strepto-cocci, was demonstrated.

Although the advent of the hot weather in the summer of 1905 was followed by a reduction in the number of cases reported, there was a recrudescence of the cerebro-spinal fever prevalence in the following winter and spring, the recorded attacks in 1906 amounting to 1,011, of which 636 were fatal. In 1907 there were 403 cases and 241 deaths. The progress of cerebro-spinal fever in Silesia and in the kingdom of Prussia can be studied in the subjoined table, which gives the number of notified cases in each of the provinces of Prussia from 1909 to 1911.

The origin of the serious epidemic of 1905-7 in Silesia has given rise to discussion. There was an outbreak in the Oppeln district in 1887, when 317 cases and 89 deaths came under observation; but these figures probably understate the incidence of the disease, for, outside the large towns, few Silesians seek medical assistance until illness has become very far advanced. Fulminant cases dying rapidly would therefore not be correctly diagnosed, but would probably be attributed to some other cause than cerebro-spinal fever. An outbreak occurred in this province in the period 1896-8, but the number of reported attacks was only about 354 during the three years. From 1898 to 1904, as has been shown, cerebro-spinal fever had been occurring each year in Silesia; so that a theory of recrudescence of the local strain of infection is not without evidence to support it. On the other hand, it is contended that, as two-thirds of the eastern boundary of the Oppeln Administrative District borders on Russia and Austria, and as it is well known that the disease was present both in Russian Poland and Austrian Galicia before, as well as during, the Silesian epidemic, it is more than probable that the outbreak was due to the importation of a fresh and more virulent strain of the infection from Russia or Austria. In support of

the latter view it is stated that there were cases in Silesia in which cerebro-spinal fever developed on the day of the patients' arrival from Russia, or on the day after, leaving no doubt that the disease had been contracted in Russian territory. Many Russian miners living close to the frontier find work in the German mining districts close by, and a number of them cross the frontier daily in going to and from their work. In this way additional facilities, it is suggested, were furnished by which the infection could be carried into the Oppeln district from Russian Poland.*

Table showing the number of notified cases of cerebro-spinal fever in each province of Prussia from 1905 *to* 1911:—

Provinces.	1905	1906	1907	1908	1909	1910	1911
East Prussia	28	18	20	21	48	8	7
West Prussia	26	7	3	6	3	6	4
Brandenburg, including Berlin	84	61	93	66	59	26	25
Pomerania	14	60	22	76	25	7	2
Posen	37	174	119	74	23	9	7
Prussian Silesia	3317	1011	403	177	93	43	20
Prussian Saxony	47	22	17	10	14	5	9
Schleswig-Holstein	21	15	74	28	14	10	5
Hannover	28	33	63	28	28	20	7
Westphalia	70	263	1059	323	245	86	36
Rhine Province	61	340	692	459	382	101	47
Hesse-Nassau	26	25	26	16	23	11	7
Hohenzollern	5	...	...	...	...	...	...
Cases in Prussia	3764	2029	2591	1284	957	332	176
Deaths	2521†	1275	1613	713	499	194†	111
Case Mortality Rate per cent.	67·0	62·8	62·3	55·5	57·3	58·4	63·1

The epidemic in Silesia which began in 1905 may be said to have lingered until 1908, in which year 177 cases were notified; but meanwhile the disease had assumed epidemic proportions in other Prussian provinces. In Westphalia, which, like Silesia, is a great coal and iron industrial area, cerebro-spinal fever began to be more prevalent than usual in 1906, especially in the mining district of Arnsberg, increasing in amount in 1907 and continuing to prevail during 1908 and 1909. Of the 1,059 cases recorded in Westphalia during 1907, 825 were referred to the district of Arnsberg, where 553 deaths were recorded from the disease. Of

* Die Uebertragbare Genickstarre im Regierungsbezirk Oppeln im Jahre 1905, und ihre Bekämpfung; von Dr. Hans Flatten, Regierungs und Medizinalrat in Oppeln.

† Later reports give the deaths in Prussia from cerebro-spinal fever as 2,587 in 1905 and 251 in 1910.

the 323 cases reported in Westphalia in 1908, 212 occurred in the Arnsberg district, where also 197 were recorded in 1909.

In the Rhine province, too, and especially in the industrial district of Düsseldorf, an epidemic developed in 1906 which reached its height in 1907 and continued until 1909. Of the 692 cases notified in the Rhine province in 1907, 507 occurred in the Düsseldorf district, where there were 280 in 1908 and 310 in 1909.

From 1905 to 1911 there was a steady decrease in the number of cases and deaths from cerebro-spinal fever reported in the kingdom of Prussia, the total recorded cases declining from 3,764 in 1905 to 176 in 1911, and the deaths from 2,521 in 1905 to 111 in 1911. The deaths from this disease in Prussia in 1912 numbered 149.

During the prevalence of cerebro-spinal fever in Germany from 1905 to 1909, which, as has been seen, was chiefly epidemic in Prussia (see table on page 145) the incidence of the disease on children under 15 years of age was very noticeable. From figures published in the *Veröffentlichungen des Kaiserlichen Gesundheitsamtes* the following table has been compiled. It shows the total number of deaths in Germany from cerebro-spinal fever in each year from 1905 to 1908, the number reported under one year of age, the number under 15, and the number over the age of 15.

The age incidence of fatal cerebro-spinal fever in Germany during the epidemic period 1905 *to* 1908 *inclusive.*

Year	Under 1 year.	1 to 15.	Total under 15.	Over 15.	Total at all ages.
1905 ...	322	1,936	2,258	457	2,715
1906 ...	147	908	1,055	336	1,391
1907 ...	231	1,069	1,300	469	1,769
1908 ...	95	448	543	336	879
Total ...	795	4,361	5,156	1,598	6,754

Calculated upon these figures, the deaths under 15 years of age for the four years' period were 76·3 per cent. of the total.

After 1909 the deaths from cerebro-spinal fever in Prussia fell considerably, and may be said to have become about normal, the disease being present only in sporadic form. During 1912, 179 attacks were recorded, and during the first seven months of 1913 there were 171 reported cases.

During 1909 and 1910 use was made of anti-meningo-coccal serum in the treatment of the disease. In 1909, of 214 persons treated by this method in Prussia 66, or 30·9 per cent., died; and of 743 persons who were not inoculated with the serum 433, or 58·3 per cent., died.

Bavaria.—Although cerebro-spinal fever has been constantly present in Bavaria during the last 22 years, it has not been seriously epidemic. In 1888 and 1889 there were, respectively, 123 and 198 cases reported, and in 1890, 212. The following table gives the number of cases and deaths reported in the kingdom of Bavaria from 1892 to 1913:—

—	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902
Cases ...	254	210	249	136	186	224	171	120	142	181	192
Deaths ...	91	111	139	58	63	97	66	49	57	52	59

—	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
Cases ...	110	275	282	*	129	72	94	65	96	48	28
Deaths ...	52	71	116	63	78	40	43	32	38	29	18

It appears from this table that of late years the incidence of cerebro-spinal fever in the kingdom of Bavaria has been decreasing.

The disease has been present in varying amount in the City of Munich and in Nürnberg, among other places. For instance, from 1907 to 1911 there were in Munich 142 cases and 67 deaths, and in Nürnberg 36 cases and 11 deaths, but there have been no epidemics.

Austria.

It has been remarked repeatedly by different writers that epidemic cerebro-spinal meningitis is comparatively rare in Austria, and that, so far as can be gathered from the scanty records available, that country has suffered comparatively little in the past from the ravages of the disease. Some cases were reported in Vienna in 1863, and in 1879 there was an epidemic in Galicia. In 1888–89 cerebro-spinal fever was prevalent in Dalmatia, Istria, and Styria, 203 cases (and 132 deaths) being referred to Dalmatia, 81 (26) to Istria, and 255 (106) to Styria. In 1892 a number of small local outbreaks were reported in various parts of Austria, and in 1894 the cases amounted to 387 (286 of which were in the Galician town of Cracow) and the deaths to 181. The disease continued to be prevalent in several provinces from 1897 to 1903, as may be seen in the following table, which gives the number of deaths recorded from cerebro-spinal fever in each of the provinces of Austria during that period:—

* The number of cases in 1906 has not been ascertained.

Deaths from cerebro-spinal fever in the Provinces of Austria from 1897 *to* 1903.

Provinces.	1897	1898	1899	1900	1901	1902	1903	Total.
Lower Austria ...	26	9	4	2	16	3	5	65
Upper Austria ...	—	—	—	—	1	—	—	1
Salzburg	1	1	—	—	3	—	—	5
Styria	—	27*	9	10	3	2	3	54
Carynthia	—	7	—	1	—	2	2	12
Carniola	—	1	—	—	—	1	1	3
Trieste...	—	1	—	—	—	—	—	1
Tirol	1	1	2	—	—	1	2	7
Vorarlberg	—	—	—	—	—	—	1	1
Bohemia	11	89	87	26	46	32	51	342
Moravia	9	21	7	3	3	8	6	57
Silesia	2	5	2	—	—	—	—	9
Galicia...	33	91	65	50	68	32	40	379
Bukowina	—	—	3	1	5	1	1	11
Dalmatia	—	—	—	—	1	—	3	4
Istria	—	2	2	2	—	1	—	7
Total	83	255	181	95	146	83	115	958

This table has been prepared from the annual figures published in the Austrian official weekly journal *Das Oesterreichische Sanitätswesen.* It will be seen that Galicia and Bohemia were by far the greatest sufferers from cerebro-spinal fever during the period covered by the table.

A small but interesting outbreak, comprising about 60 cases, occurred during 1898 in the mining district of Trefail, in the province of Styria. The first cases were noticed in February, and the prevalence lasted till May. Coincidently with characteristic cases of cerebro-spinal fever, having distinct retraction of the head and often followed by paralytic sequelæ, there was a prevalence of "influenza" in the locality. Suspicion arose that both diseases might be due to a common infection, and, in consequence, a Government Commission of four medical experts was appointed to investigate the outbreak. The presence of the meningo-coccus was subsequently demonstrated in the exudation on the brain in fatal cases, and it was also found in the nasal secretion of the sick. The Commission appeared to favour the view that the so-called "influenza" that had been epidemic in Trefail was not a genuine, but only a pseudo-influenza, caused by the diplo-coccus intra-cellularis meningitidis.† These "influenza" cases, therefore, in the later stages of the epidemic, which extended outside Trefail to other adjacent communes, were regarded as mild or abortive instances of the current cerebro-spinal fever infection. In this respect the outbreak presented some features resembling those which have already been men-

* Another report gives 33 deaths in Styria from Cerebro-spinal fever during 1898.

† Epidemie von Meningitis cerebrospinalis in Trefail, in Steiermark (aus dem Sanitätsdepartment des K. K. Ministeriums des Innern).

tioned as having occurred in England and elsewhere in 1890 and subsequently, in which the cerebro-spinal fever cases were surrounded by numerous cases of a less severe kind, generally described as "influenza," but now regarded as having been, in all likelihood, minor manifestations of the same meningococcal infection.

It is admitted that cerebro-spinal fever has been endemic in Galicia for many years. In the early part of 1905 a somewhat severe epidemic of cerebro-spinal fever was reported in Western Galicia, mainly in districts bordering upon Austrian and Prussian Silesia, where the disease was also very prevalent at the time. In Western Galicia alone some 79 communes were invaded, and up to April 8th 437 persons had been attacked, of whom 188, or 43 per cent., died.

The epidemic did not subside until July, and up to that time, according to an official report,* there had been recorded 1,660 cases in Galicia, with 712 deaths, giving a case mortality rate of 42·9 per cent. These cases and deaths occurred in two distinct centres, the first of which was near the Silesian border; the chief districts there affected being Cracow 218 cases (and 120 deaths), Biala 97 (57), Chrzanow 64 (30), and Wadowice 58 (24). The second centre was situated further to the east of Galicia (between the Vistula and the San, and projecting northwards into Poland); it included such districts as Nisko, which had 151 cases (and 53 deaths), Lancut 151 (42), Mielic 115 (42), and Jaroslau 124 (46). There is a great deal of intercommunication between these two groups of districts and Prussia, especially with Prussian Silesia. During the first eight months of 1905 as many as 53,409 persons are known to have gone from Western Galicia to seek employment in Prussia. The majority of these workers returned to their homes to spend the week-ends and holidays; so that they acted as links of communication between Prussia and Galicia, and in many instances they are believed to have brought the infection back with them to their homes. During the latter part of 1904 and early months of 1905, as has been said, a very severe and widespread epidemic of cerebro-spinal fever raged in Prussian Silesia, attacking no fewer than 3,317 persons, of whom 1,860 died (see page 143). Bacteriological examination of the nasal secretions of some of the Galician workers, apparently themselves in good health, who had returned from Prussian Silesia to visit their families, showed that the meningo-coccus was being harboured by them in the naso-pharynx. Although, as has been stated, cerebro-spinal fever has been endemic in Galicia for a number of years, it cannot be denied that the evidence available points strongly to the conclusion that the Galician epidemic of 1905 was due in a large measure to a fresh strain of infection imported, as has been described, by labourers from Prussian Silesia. The incidence of the disease was, as usual, heaviest upon children, who comprised nearly 90 per cent. of the patients.

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* Bericht über die Anlasslich der Meningitis-Epidemie in Galizien im Jahre, 1905, von Dr. Stanislaw Droba und Dr. Paul Kucera ; Beilage zu " Das Oesterreichische Sanitätswesen Nr. 50, vom 13 Dezember, 1906.

Coincidently with the epidemic in Western Galicia there occurred a prevalence of cerebro-spinal fever in some communes in the eastern part of Austrian Silesia. The cases were somewhat widely scattered over 23 communes, in which, up to the end of June, 1905, 165 cases had been reported; the majority of them occurred in the districts of Bielitz, Freistadt, and Friedek, mostly single cases in families. Special investigations were made in Austrian Silesia by Professor Weichselbaum (the discoverer of the meningo-coccus) and Professor Ghon, both of the University of Vienna, under the direction of the Austrian Government. They examined new cases to ascertain the true nature of the current disease, and also tested, for the presence of the meningococcus, the nasal secretions of healthy persons suspected of being carriers of the infection.

From the end of 1904 to July 8th, 1905, some 60 cases were reported in the Austrian province of Moravia, chiefly in the districts of Märisch-Ostrau, Mistek, and Märisch-Weiskirchen; half of those attacked were under five years of age. One of the Austrian provinces in which cerebro-spinal fever has been endemic for some time is Bohemia (see table on page 148), and, though there was no epidemic there in 1905, cases and deaths continued to be reported later, namely, 46 cases in 1906, 56 in 1907, and 38 in 1908.

During 1910, 244 attacks came under observation throughout Austria, 84 of which were referred to the province of Moravia, 50 to Galicia, 48 to Lower Austria (including Vienna), 21 to Bukowina, and only 14 to Bohemia. After the Galician epidemic of 1905 the infection appears to have been conveyed to Vienna, where, in that year, 31 cases and 15 deaths were reported. The prevalence continued in subsequent years, as may be seen by the following table:—

Cerebro-spinal Fever in Vienna, 1906-1914.

——	1906	1907	1908	1909	1910	1911	1912	1913	1914 5 months only.
Cases ...	72	306	124	56	32	29	17	25	17
Deaths ...	54	196	69	48	22	19	6	10	2

During the prevalence of the disease in Vienna it was rare to find more than a single case in a family. The fatal instances were chiefly found among young children and infants.

Owing to the outbreak of war in August, 1914, the information from Austria for that year is incomplete, and for 1915 almost altogether lacking, the usual records contained in the *Sanitätswesen* having ceased to reach this country. So far as can be learned, there were 81 reported cases in Austria during 1913, and 51 in the first half of 1914; of the latter number 17 were referred to Vienna and 20 to the Galician town of Cracow.

In November, 1913, the s.s. *Eugenia*, from the Austrian port of Trieste, arrived at Rio de Janeiro, having on board a number of cases of "meningitis"; some of the passengers had died from the disease on the voyage. Of 827 passengers carried by the vessel from various Mediterranean ports, 180 had embarked at Trieste, but the precise source of the infection was not satisfactorily determined.

Hungary.—Reports received in this country from Hungary are scanty, and consequently there is little information available regarding the incidence of cerebro-spinal fever there. The disease was present, however, in the capital, Budapest, during 1906, and about 20 cases were also reported in 1913, and others again in 1915, but the disease may be said to have occurred only in sporadic form.

Bosnia and Herzegovina.—In recent years cases of cerebro-spinal fever have been reported in Bosnia and Herzegovina, but in no great amount, except in 1907, when some 234 cases came under official observation. During the spring of 1913 some attacks also came under notice, but they were only sporadic.

Russia.

Cerebro-spinal fever is known to have been of not uncommon occurrence in European Russia in the past, but precise information regarding its incidence in recent years is difficult to obtain. Hirsch says that the malady was first seen in 1863 in Kaluga, 188 miles south-west of Moscow, and that it was present in Petrograd in 1864 and in Poland in 1865. It was present in the Crimea during 1867–68. Clemow* states that the number of reported cases from 1893 to 1895 in different parts of the country varied from 7 to 50 per million of the population, the lowest figures being those from the territory of the Don Cossacks, and the highest from the Baltic Provinces and Poland. Reference has already been made to the German allegations that cerebro-spinal fever was brought at times into Prussian Silesia from Russian Poland. Cerebro-spinal fever as a cause of death does not usually appear in the French translations of the annual reports of such Russian cities as Moscow, Warsaw and Petrograd, but occasionally mention is made of it. For instance, in 1898, 1899 and 1900 there were, respectively, 44, 59 and 85 deaths attributed to cerebro-spinal fever in Moscow, and the disease was still present in 1902. In 1909 and 1910 the number of fatal cases in that city was given respectively as 128 and 88. From another source it is stated that 37 deaths from cerebro-spinal fever occurred in Warsaw from 1897 to 1901.

It is probable that this malady still occurs in certain towns and districts of European Russia, though definite information on the point is lacking. During the first half of 1914 cerebro-spinal fever was reported to be present in Moscow, but since the outbreak of war no information has been received from Russia respecting infectious or epidemic diseases.

* "Geography of disease."

Roumania.

Very little is known respecting the incidence of cerebro-spinal fever in Roumania. It was present there in the winter of 1869, and, according to Clemow, the disease has not been altogether absent from that country in recent years. In 1912, 14 deaths were reported from this cause in the larger towns of Roumania, and in 1913 there was an outbreak in Bucharest, the capital, but the details have not been received.

Greece and the Islands of the Mediterranean.

Since 1881 cerebro-spinal fever has become endemic in some parts of Greece, cases being reported every year during the colder months. But the information on the subject available from Greece is very limited. Professor Typaldos, of Athens, in a memoir presented to the Académie de Médecine at Paris in 1883, drew attention to three outbreaks of cerebro-spinal fever in Greece in 1861, 1869 and 1880-81, in which the influence of extremely cold weather on the development of the epidemic was very marked. The late Sir Richard Thorne Thorne, in a report to the Local Government Board in 1888, "On recent occurrences of Epidemic Cerebro-Spinal Meningitis in the Basin of the Mediterranean," mentioned that at Athens and Piræus isolated cases had been occurring in the earlier part of 1888, and that the disease, previous to this, had been reported occasionally at Patras, the chief port in the west of Greece, where it appeared amongst prisoners and the poorer classes of the population.

In more recent years the disease has been reported in various parts of Greece. In the winter of 1910-11 an epidemic occurred in Athens, Piræus and the adjoining districts, and also in the provinces of Thessaly, Peloponnesus and Triphylia. In the Athens district alone some 400 cases and 191 deaths were recorded; but, as notification was not compulsory, it is very possible that there were more attacks. The epidemic was observed to begin after a long spell of inclement weather. The fatality, it is stated, was greatest at the beginning of the epidemic when the case mortality rate was 58 per cent.; but, after use had been made of the anti-meningo-coccic serum in the treatment of the cases, the rate fell to between 20 and 22 per cent. In the provinces, during the first three months of 1911, there were 289 cases and 49 deaths reported, but these figures do not cover the whole period of the epidemic. During the first half of 1912 cerebro-spinal fever was very prevalent in and around Athens and in Thessaly. In the course of the eight weeks ended May 18th more than 600 cases were reported, 180 of them in the week ended April 6th. In the kingdom of Greece, during the first three months of 1913, there were 508 cases and 104 deaths, of which some occurred in Athens and the surrounding district and others at Patras. During November, 1913, four fatal cases occurred in Athens. In January, 1914, cases of cerebro-spinal fever were reported in the military barracks at Kalamati or Kalamae, a seaport in Greek Peloponnesus; and, about the same time, an epidemic occurred

in Missolonghi, a seaport on the shore of the Gulf of Patras, but no details have been given. In the same year "many" cases came under observation at Piræus; also at Patras some 25 cases were recorded. Mention was made in the Press that a Greek ship the s.s. *Athenai*, conveying emigrants to the United States from the Piræus and other Greek ports, had, on her arrival at the New York quarantine station, landed three emigrants who were discovered to be suffering from cerebro-spinal fever, and that two other cases developed subsequently among the steerage passengers while under observation at the quarantine station. It may be mentioned that in 1912 about 18 alien emigrants, most of them Greeks, arrived in New York suffering from cerebro-spinal fever on board vessels that had come from Greek and other ports in the Mediterranean.

Crete.—An outbreak of cerebro-spinal fever occurred in the village of Bahia in the district of Candia in Crete in January, 1886, and since that time sporadic cases have been heard of in various parts of the island, especially to the south-west, but no details of these occurrences have been obtained.

In 1913 the British Consul-General at Canea reported that several cases had recently been observed in the districts of Candia and Rethymo and that a supply of anti-meningo-coccic serum had been obtained from France for the treatment of the disease. It was believed that there had been a reintroduction of the infection into the island by Cretans returning from the Balkan campaign. Up to April, 136 cases had been reported, with only 11 deaths. The infection spread later to Pedalia and Malevise in the East of the island. In January and February, 1914, after an interval of six months or more, there was a recrudescence of the outbreak at Candia, and also at Canea, which is the present capital and chief commercial town of Crete.

The Ionian Islands.—During 1914 cases of cerebro-spinal fever were reported in the island of Corfu; and at Zante, another of the group, an epidemic of the disease occurred in that year, the infection having been, it is alleged, brought from Athens. The authorities procured a supply of the anti-meningo-coccic serum and it was administered gratuitously to those attacked.

Samos.—This island, which lies close to the coast of Asia Minor, and which was formerly under Turkish rule, has been in recent years transferred to Greece. In 1888 a limited outbreak was reported in the large village of Mytilinous, which had then a population of about 4,000. Thirteen cases with five deaths had come under observation up to the time of the report, but no subsequent details have been received, nor is it known if the disease has reappeared in later years.

Cyprus.—Dr. Heidenstam, C.M.G., at that time Principal Medical Officer for Cyprus, reported in February, 1888, the occurrence of an outbreak of cerebro-spinal fever which had begun in the town of Nicosia, the capital of the island. The infection subsequently

spread to some villages in the districts of Nicosia, Kyrenia (or Kerinia), and Famagusta. In the town of Nicosia itself 132 cases and 27 deaths occurred. Up to June, 273 cases and 35 deaths had been recorded in the island. They were distributed as follows:—

Nicosia district, including the town	216 cases,	60 deaths.
Famagusta district	26 ,,	12 ,,
Kyrenia	28 ,,	11 ,,
The town of Larnaca	3 ,,	2 ,,
Total	273 ,,	85 ,,

The majority of the cases occurred during the cold and wet weather of February and March. In the town of Nicosia the disease was mostly seen in the low-lying quarters. Side by side with the typical attacks were numerous cases of minor illness characterised by persistent headache and some fever but with no pain or stiffness in the neck. In a communication made to the Académie de Médecine, Paris, Dr. Derbys, of Nicosia, stated that the disease attacked chiefly the poorer classes or those inhabiting small, damp and badly ventilated houses, as well as those who had no means of protecting themselves against the inclemency of the weather.*

More recently, from December, 1908, to May, 1909, cerebro-spinal fever was epidemic in the districts of Nicosia, Papho, or Bafo, Kyrenia and Famagusta, these having a combined population of about 237,000. No fewer than 1,153 attacks with 600 deaths were reported; calculated on these figures the case mortality rate was 52 per cent. In a number of instances the attack was of the fulminant variety, death taking place within 24 hours of the onset.† During 1913, 25 cases were reported and 13 in 1914.

The Island of Gozo.—This island, a British possession, is situated about four miles north-west of Malta, and in it the presence of cerebro-spinal fever was reported in 1887, a number of cases and deaths coming under observation. Since then, however, no information has come to hand as to any recurrence of the disease on the island.

Malta.—Little is known as to the occurrence of cerebro-spinal fever in Malta, but in the fiscal year 1914–15 two cases and one death were reported. It can hardly be accepted that the absence of information is a proof that the disease has not been occurring in Malta.

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* See the Annual Report of the Medical Officer of the Local Government Board for 1888, Sir Richard Thorne Thorne's "Notes on the Recent Occurrences of Epidemic Cerebro-spinal Meningitis in the Basin of the Mediterranean."

† Report by Dr. G. A. Williams, Acting Chief Medical Officer for Cyprus.

Italy.

Cerebro-spinal fever has been known to occur in Southern Italy since 1839. From that time onwards occasional outbreaks have been recorded in different parts of the country, for example, at Bologna in 1873 and at Rome and Naples in the winter of 1873-74. In 1883 it appeared in Sicily, and has since then recurred there from time to time. The disease was observed also in various communes in the island of Sardinia from 1883 to 1888, the places most affected being Decimomannu, Assemini, and Terranova. Although the number of attacks in these places has not been given, it is stated that the case mortality rate was 30 per cent., except at Terranova, where the disease was specially virulent, every attack proving fatal. From 1884 to 1886 cerebro-spinal fever was prevalent in the Italian Army, and during that period 131 soldiers died from it.

In 1893 and 1894 there was a very severe epidemic of cerebro-spinal fever in Italy, no fewer than 3,276 persons losing their lives from the malady.

The following table gives the number of deaths reported in Italy from cerebro-spinal fever from 1885 to 1914 inclusive:—

Year.	Deaths.	Year.	Deaths.
1885	223	1900	21
1886	46	1901	5
1887	326	1902	9
1888	93	1903	3
1889	171	1904	80
1890	64	1905	288
1891	12	1906	91
1892	28	1907	92
1893	2,014	1908	23
1894	1,262	1909	27
1895	176	1910	35
1896	409	1911	58
1897	216	1912	23
1898	31	1913	10
1899	74	1914	23
Total in 15 years ...	5,145	Total in 15 years ...	788

It is obvious from the above figures that during the first half of the 30 years included in the table cerebro-spinal fever was far more fatally prevalent than in the second half of the period, 5,145 deaths being referred to the former and only 788 to the latter. The number of persons attacked by cerebro-spinal fever in Italy during these 30 years has not been ascertained.

It is possible that in Italy, as in some other countries, the diagnosis of the disease being difficult, cerebro-spinal fever deaths may have been recorded under other headings.

For purposes of comparison, the deaths from all forms of meningitis in the kingdom of Italy from 1896 to 1912 have been taken from the official report, *Statistica delle Cause di Morte*

nell' Anno 1913, and placed in parallel columns in the following table:—

Year.	Deaths from meningitis in the Kingdom of Italy.		
	Simple meningitis, cerebral and spinal.*	Tuberculous meningitis, and acquired hydrocephalus.†	Epidemic cerebro-spinal meningitis.
1896	16,602	4,861	409
1897	15,235	4,453	216
1898	15,443	4,535	31
1899	13,898	5,898	74
1900	14,407	5,920	21
1901	13,676	5,751	5
1902	13,923	5,515	9
1903	14,655	5,471	3
1904	14,049	5,465	80
1905	13,026	5,683	288
1906	13,057	5,679	91
1907	11,734	5,864	92
1908	11,792	5,971	23‡
1909	12,476	6,010	27‡
1910	11,958	5,898	35‡
1911	13,184	6,720	58‡
1912	10,799	5,691	23‡
1913	11,075	6,003	¶

Some of these figures appear to need explanation; for example, it seems strange that there should be 2,385 fewer deaths from simple meningitis, and 1,029 fewer from tuberculous meningitis in 1912 than in 1911. Sporadic cases of cerebro-spinal fever, it is admitted, often pass unobserved; and sometimes it is only when the disease becomes unmistakably epidemic that its true nature is recognised.

In 1915 it was reported that cerebro-spinal fever was prevalent among the military at the garrison stations of Capua, Naples, and Salerno. Scattered cases were also observed in various parts of Italy among the civil population.

Switzerland.

Although cerebro-spinal fever was first recognised as a distinct entity in Europe at Geneva in 1805, the disease has, so far as can be learned, never been epidemic to any extent in Switzerland. Occasional outbreaks, however, have been reported from time to time. In recent years cases of cerebro-spinal fever have been reported annually, but in no great amount. The following table

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* Meningite semplice cerebrale e spinale.

† Meningite tubercalare, idrocefalo acquisito.

‡ The deaths from epidemic cerebro-spinal meningitis for these years are taken from the summaries of deaths given in the *Bollettino Sanitario*.

¶ Figures not received.

gives the number of cases notified in Switzerland from 1907 to 1914 inclusive:—

1906	1907	1908	1909	1910	1911	1912	1913	1914	1915
72	105	135*	118	74	38	31	30	30	102

These figures are taken from the annual *Berichte des Schweizerischen Departments des Innern (Abteilung Gesundheitsamt) über seine Geschäftsführung* for the years in question.

It may be mentioned that the Serum and Lymph Institute in Bern supplies each year the anti-meningococcal serum at half price to the municipalities and to the public hospitals of the country.

Portugal.

Cerebro-spinal fever appeared in Portugal in 1860, in the district of Castello Branco, some of those attacked being soldiers. It continued to be prevalent till 1864, when it seemed to disappear altogether from Portugal, no more being heard of the disease until 1900, when it reappeared at Quintanilla, a village of 400 inhabitants in the Bragança district. In 1901 it spread to a number of localities, including Villa Real, Castello Branco, Porto, Portalegre, and Lisbon. The disease became very widespread, and up to 1903 (at which time only sporadic cases were coming under observation) the number of cases, in three years, had reached nearly 4,000. Drs. A. Bettencourt and C. Francai, in a communication to the Royal Institute of Bacteriology, Camara Pestana, Lisbon, state that some cases sent to hospital as cerebro-spinal fever were shown bacteriologically not to be of that nature. Therefore, allowing for all such cases, these observers estimate the total attacks during the three years at 3,000. At Lisbon, of 310 persons treated in hospital the majority were from five to 15 years of age. In this particular instance the military population suffered but little. Owing to the imperfect way in which statistics are compiled in Portugal, it is not possible to estimate the case mortality in the epidemic of 1901-1903.

Very little information ordinarily reaches this country as to the occurrences of infectious disease in Portugal, and since the revolution of 1910 none at all has been received; so that for recent years no statement can be made as to the incidence of cerebro-spinal fever in that country.

Spain.

So far as can be learned from various sources, Spain has suffered but little in recent years from cerebro-spinal fever.

* It is known that other cases occurred that were not officially reported in 1908.

Clemow states that the disease is comparatively rare in that country. The only recent reference that has been met with regarding the occurrence of cerebro-spinal fever in Spain is that, in 1901, when the malady was widely epidemic in Portugal, cases were reported in the town of Crevillente, 20 miles from the port of Alicante, on the eastern coast of Spain; and that, in consequence, the Central Health Authority at Madrid had ordered special measures to be enforced against the malady. So far as can be ascertained, the disease has not been prevalent in Spain since then.

Turkey.

Records respecting cerebro-spinal fever in Turkey are very meagre; nevertheless, there are indications that the disease has not been altogether absent from that country during recent years. In 1888, the malady appears to have been present in Syria at Beirût and Jerusalem, but no particulars as to the incidence appear to have been published. The report of the German hospital at Constantinople for 1909 mentioned four cases and three deaths from cerebro-spinal fever at that institution during the year, and from another source it is stated that 31 persons had died of the disease in the city. In 1910-11, some 28 deaths referred to cerebro-spinal fever occurred in the general population of the city. During 1911, some sporadic cases were reported by the Municipal Medical Office of Alexandretta or Scanderoun, the port of Aleppo, and about the same time cases appear to have occurred at Aleppo itself. It is more than probable that there has been of late years a far greater incidence of cerebro-spinal fever in European and Asiatic Turkey than the above scanty records indicate.

During 1915, after the atrocities inflicted upon the Armenians by the Turks, many refugees fled for protection into the districts into which the Russian forces had penetrated, and it is stated that a considerable mortality from "spotted fever" (cerebro-spinal fever ?) occurred among these unfortunate people in Erivan, Etchmiadzin, Ugdir and Alexandropol, the mortality from this cause among children being especially high. This latter fact would appear to show that the so-called spotted fever was not typhus, which is not markedly fatal in children as a rule.

Egypt.

Cerebro-spinal fever has been present in Egypt during recent years, but not in any great amount. Alexandria, Cairo and some of the other chief towns have reported cases annually. In Alexandria in 1904 there were 33 cases (and 24 deaths); in 1905, 21 (16); and in 1906, 8 (4). During 1912 there were 82 cases and 46 deaths from this disease recorded in the 20 chief towns of Egypt. In 1913 there were 164 cases and 63 deaths, of which 133 (43) occurred in Cairo, 20 (11) in Alexandria, 8 (1) in Port Said, and 4 (3) in Damietta. During 1914, 276 cases with 111 deaths occurred in Egypt, and of these 144 (59) were referred to Cairo, 15 (7) to Alexandria, and 86 (31) to the province of Dekalieh. In the first quarter of 1915, 27 cases and 15 deaths from

cerebro-spinal fever were reported in the principal towns, and of these 22 (12) occurred in Cairo, but none in Alexandria.

In the Anglo-Egyptian Sudan cases are said to have occurred, and an outbreak was reported at Omdurman in 1898 which led at the time to the removal of the Anglo-Egyptian troops from that unhealthy neighbourhood. Some past outbreaks in this region were regarded as due to "typhus," but more recent observations by British Army Medical Officers have tended to the view that they were occurrences of cerebro-spinal fever.

British East Africa.

Cerebro-spinal fever is said to have been prevalent from time to time of late years in British East Africa; and it has been surmised that the occurrence of the disease at Cape Coast in West Africa during 1900 was due to infection brought to that place from Mombasa by imported labourers.

In 1906 and again in 1907 cases were reported at Nairobi, but none of them appears to have been bacteriologically confirmed. During 1913 there was a widespread epidemic in British East Africa, in which 1,128 cases came under observation; 228 of the cases and 152 deaths occurred in the mountainous area. In Nairobi, during that year, 233 cases and 79 deaths were recorded, and it is stated that male youths and adults suffered most, the incidence among women and young children being small. On the whole, the type of the disease appears to have been comparatively mild. Of 143 of the cases admitted to hospital at Nairobi 127 (37 of which were undoubtedly malignant cases in which death was inevitable) were treated with Soamin. Of the 90 remaining less malignant cases thus treated 34, or 37·8 per cent., died. The disease continued to show itself in Nairobi during 1914, and cases also occurred at Mombasa, Kisumu, and in the Kavirondo district. In the 1913 outbreak 153 cases were examined bacteriologically, and 123, or 80 per cent., yielded the meningo-coccus.*

South Africa.

The Transvaal.—In the Johannesburg district, deaths from meningitis are not infrequent, and two main types of the malady are recognised; the one, that of cerebro-spinal fever, caused by the meningo-coccus, the other, pneumo-coccal meningitis, due to the pneumo-coccus. In 1898, a paper in the *Lancet*, written by three Johannesburg medical practitioners, discussed the subject of pneumo-coccal infections on the basis of at least 100 cases which had come under their notice among natives working in the mines. The possibility, in cases of meningitis, of a mixed infection, due to both the meningo-coccus and the pneumo-coccus being simultaneously present in the body was suggested about

* "Epidemic Cerebro-spinal Meningitis in Nairobi, British East Africa," by Dr. J. O. Shircore and Dr. P. H. Ross; Journal of Tropical Medicine and Hygiene, 1913, Vol. vii., No. 2.

this time by Sir William Power, the Board's late Medical Officer, but according to the testimony of Dr. Charles Porter, Medical Officer of Health for Johannesburg, no direct evidence in support of this surmise has, so far, been obtained in his district. In the biennial report of Dr. Porter for the fiscal years 1904-5 and 1905-6, it is stated that during that period 338 deaths in the municipality of Johannesburg had been ascribed to meningitis of various kinds, namely, simple meningitis 215, spinal meningitis 3, cerebral meningitis 8, and cerebro-spinal meningitis 112. Of this total, 57 were whites, 279 natives, and 2 Asiatics; and, of the 57 whites, 37 were children. Of the 279 natives, 170 were in the age group 15 to 25, and 98 were over 25 years, only 11 being under 15 years of age.* Of the 379 deaths, 168 were attributed to meningitis and 98 to cerebro-spinal meningitis; but Dr. Porter remarks that there is little doubt that the deaths ascribed to primary meningitis in the mine natives over the age of 15 years were in reality due to epidemic cerebro-spinal meningitis. Bacteriological examination of all native cases could not, however, be carried out. In discussing the difficulties met with in the diagnosis of the disease at that time, Dr. Porter mentions that, during the two years' period in question, post-mortem examination at the Johannesburg mortuary showed that no fewer than 75 natives and four white persons had died of cerebro-spinal meningitis which had not been diagnosed during life.

In his most recent annual report, received by this Board at the time of writing, namely, that for the fiscal year 1913–14, Dr. Porter, after mentioning that 104 deaths had been recorded in that year from meningitis, states that from July 1st, 1906, to June 30th, 1914, the Government Bacteriologist had examined material from 447 instances of suspected cerebro-spinal fever, and that the meningo-coccus was found in 158 of them, the pneumo-coccus in 87, the strepto-coccus in 21, both the pneumo-coccus and the strepto-coccus in 2, the tubercle bacillus in 1, B. pyocaneus in 1, coliform bacillus in 1, and B. paratyphosus in 1. In no single instance were the meningo-coccus and the pneumo-coccus found present together. In the remaining cases, none of the already-named pathogenic organisms was found in the material submitted for examination.

Natal.—In 1890, an outbreak of cerebro-spinal fever was reported in Natal among the natives, but, with this exception, little has been heard of the disease in that province.

Cape Colony.—During 1883, cerebro-spinal fever was beginning to be prevalent in Cape Colony, and in 1884 there was a somewhat severe outbreak, cases continuing to occur up to 1890. In 1896, 11 deaths from this cause and 31 others from "cerebro-spinal meningitis" were recorded in the Colony, seven of the former and 16 of the latter being referred to Cape Town.

* The majority of the natives in the Johannesburg district are of working age and are mostly residing only temporarily in the locality.

In 1897 and 1898, the disease was again prevalent in the north of the Colony and at Malmesbury, 45 miles by rail from Cape Town, as well as in the Durbanville district of Cape Town. In 1901, 14 deaths in Cape Town were attributed to cerebro-spinal fever, namely, those of six Europeans and eight natives. From 1902 to 1913 very little was heard of the disease in Cape Colony, except that in 1908 a single death from it was recorded, and that in 1913 a single patient suffering from the malady was admitted to the Cape Town isolation hospital from outside the municipality.

British West Africa.

In 1900, an outbreak of cerebro-spinal meningitis occurred at Cape Coast among a number of native carriers who had been brought from Mombasa for duty with the Ashanti Field Force. About 3,000 of these carriers arrived on board transports, some being ill and others in a poor physical condition. So far as was known none of them presented on arrival any symptoms suggestive of cerebro-spinal fever, but in the evening after landing two of them developed retraction of the head and other features suspicious of this disease. Soon afterwards, about 30 fell ill, all but three of them among the fresh arrivals from East Africa. Altogether 80 cases of cerebro-spinal fever were reported, and the mortality is said to have been high, but the precise number of deaths which occurred in this outbreak has not been ascertained.

German West Africa.

Little has been heard of epidemic cerebro-spinal meningitis in the German West African Colonies, except that it has been known to occur in the Cameroons.

French Equatorial Africa.

In 1904 cerebro-spinal meningitis was observed in the French Sudan, and there occurred an epidemic at Kayes, a town of the Upper Senegal-Niger, having railway communication with Dakar and other places; cases were also observed in that year at Tivouanne, among the natives. During 1905, the disease recurred at Tivouanne, especially among the native children, and it was reported at Dakar, the capital of Senegal. Cases also occurred at Timbuctoo and at Niamé. The disease was likewise noted in 1905 at Onaghadougou, the capital of Mossi, in the Sudan.

In 1906 cerebro-spinal fever was widely prevalent in the Sudan, particularly in the vicinity of the Niger. Many deaths occurred at Brandiagara and Mossi, as well as in the neighbourhood of Niamé.

During 1906 the infection was carried to Dahomey by caravans from the south, and raged in other parts of West Africa along the left bank of the Niger. Details of these prevalences, however, have not come to hand.

Algeria.

Frequent reference has been made by French writers on cerebro-spinal fever to the fact that the disease has often appeared in Algeria, but precise details of these occurrences have not been obtained. The available information shows, however, that somewhat severe epidemics were reported from 1840 to 1847. Some authorities believe that the disease was brought into the country by the French army of occupation. It is known that in more recent times, as for example in 1868 and from 1896 to 1903, the malady has been present in Algeria and that it manifested itself again during 1909 and 1910; but definite particulars as to these occurrences are wanting in any of the reports received by the Board.

India.

Until comparatively recent years it was generally believed that cerebro-spinal fever did not occur in India, a belief for which probably Hirsch's writings were largely responsible.* But there can be no question that the disease is often present in certain parts of India, particularly among the native prisoners in the Indian jails, notably those of Bengal. So far as can be ascertained, the existence of cerebro-spinal fever in India was first recognised by Vandyke Carter at Bombay in 1878, but it was not until 1881 that statistics of the malady first appeared in the tables which accompany the annual reports of the Sanitary Commissioner with the Government of India. These tables, however. deal only with the British Army in India, with the Native Troops, and with the population of the Indian prisons. There are no similar figures for the general population, among whom the malady is doubtless of frequent occurrence. The following table has been compiled from the statistics referred to. It shows cases and deaths from cerebro-spinal meningitis in the Native Army and in the population of the Indian jails from 1881 to 1913, inclusive. The average strength of the Native Army during the period in question may be taken as having been about 140,000, and the population of the jails as about 100,000. As only seven cases and three deaths were recorded from the disease in the British Army in India during the 33 years under consideration, they have not been shown in the table. It has to be remembered in connection with the incidence of cerebro-spinal fever on the prison population of India that the figures given in the table relate mainly to individuals between the ages of 16 and 60; and that, therefore, cases occurring among children, who usually form, according to some authorities, about 50 per cent. of the attacks, are statistically unrecorded.

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* Hirsch stated in his Handbook of Geographical and Historical Pathology that the Tropics and the whole of the Southern Hemisphere had escaped altogether from the disease, and that the southern distribution of this malady is limited by 30° N. latitude.

Table showing cases and deaths from cerebro-spinal fever in the Native Indian Army and in the Prison Population of India, from 1881 *to* 1913 *inclusive.*

Year.	The Native Indian Army.		Native prisoners in jails.		Remarks.
	Cases.	Deaths.	Cases.	Deaths.	
1881 ...	2	—*	1	—†	* 10 deaths also from "meningitis." † 21 deaths from "meningitis."
1882 ...	—	—	2	2*	* Also 20 deaths from "meningitis."
1883 ...	1	1	7	5	——
1884 ...	1	1	18	12	——
1885 ...	12	8	11	13	——
1886 ...	3	2	29	20	——
1887 ...	—	—	25	17	——
1888 ...	—	—	38	28*	* Also 13 deaths from "meningitis."
1889 ...	—	—	48	31†	† All in Bengal jails.
1890 ...	—	—	23	22	——
1891 ...	2	2	35	29	——
1892 ...	—	—	17	15	——
1893 ...	—	—	15	10*	* All in Bengal jails.
1894 ...	—	—	4	4	——
1895 ...	—	—	8	5	——
1896 ...	—	—	7	7	——
1897 ...	—	—	13	10	——
1898 ...	1	1	24*	15*	* 18 cases and 12 deaths in Bengal jails.
1899 ...	12	11	29	24	——
1900 ...	3	2	99	79	——
1901 ...	28	21	141	102*	* Also 10 more deaths from "meningitis."
1902 ...	18	17	136	108*	* Also 18 more deaths from "meningitis."
1903 ...	6	4	34	27	——
1904 ...	6	4	23	18	——
1905 ...	1	1	11	10	——
1906 ...	3	2	12	12	——
1907 ...	3	3	13	11	——
1908 ...	2	1	24	18	——
1909 ...	1	0	32	18	——
1910 ...	2	2	16	1	——
1911 ...	4	1	17	13	——
1912 ...	5	2	11	9	——
1913 ...	2	2	9	6	——
Total in 33 years.	118	88	932	701	——

Reckoned on these figures the case mortality rate from cerebro-spinal fever among the native troops was 74·6 per cent. and among the prisoners 75·2.

It is not denied that cases of cerebro-spinal fever may have passed unrecognised in the Indian jails during this period. Various reasons may account for this, such as the difficulties

connected with diagnosis and the want of familiarity of observers with the less distinctive character of the disease in its milder forms. The presence, indeed, of the malady among the general population, especially in Calcutta, during the increased prevalence of 1901 and 1902 was admitted by the Sanitary Commissioner in his annual reports. It is known that in the earlier years of the period dealt with in the above table, cerebro-spinal fever being unfamiliar to the medical attendants, cases were diagnosed as "congestive apoplexy" or as "inflammation of the brain," so that it is tolerably certain that the figures in the table understate the incidence of the disease in Indian prisons. As has been said, the prisons in Bengal, especially those at Bhagalpur* and Alipore, have been more affected by cerebro-spinal fever than those elsewhere, but cases have occurred in places as wide apart as Shikarpur, in Sinde, and the Andaman Islands.

In 1901, which, as may be seen from the table, was a year in which the malady was more than usually prevalent, cases occurred in the native regiments at Sialkot, and in the Chitral garrison in Kashmir; and about the same time the disease was reported as being prevalent throughout the lower Chitral Valley, infection having been conveyed from Asmar. Cases also occurred in Kafiristan to the west of Chitral. In the same year, cases were reported at Rangoon, in Burma, which had received their infection from Calcutta, where the disease is often present. Numerous cases have from time to time occurred among the coolies at the Calcutta Emigration Depôts. In 1900, 41 cases were detected at two of the Calcutta Emigration Depôts. In the report of the Protector of Emigrants, published in 1901, it is mentioned that out of a total of 215 deaths from all causes "during the past year" on board emigrant ships from Calcutta, as many as 66 were due to cerebro-spinal fever. In 1901-2 there was an epidemic in the prison at Mung-Rasul, in the Punjab, when 73 cases were reported, with a case mortality rate of 68 per cent. In 1903-4, cerebro-spinal fever was reported to be prevalent in the north-west frontier province at Dera Ghazi Khan and district. In one village, 23 persons were attacked and 20 of them died. It has to be remembered that cerebro-spinal fever, though present among the general population in various parts of India, might easily escape notice, considering the circumstances of that country; its teeming population, and the fact that plague and cholera are liable to assume severely epidemic proportions and thus overshadow any other prevalent disease. As one writer has observed, a disease with a comparatively slight incidence, such as cerebro-spinal fever, would have every chance of being overlooked and neglected. Natives, too, are apathetic, and many of them do not seek skilled medical advice when attacked by illness. The occurrence of the malady in jails was largely attributed at one time to dust storms, or to employment in a dusty occupation, the irritation of the air passages, induced by inhalation of the dust, being regarded as an important predisposing cause. That the infection could be conveyed by

* Bhagalpur was transferred from Bengal to the new province of Bihar and Orissa when the latter was constituted in 1912.

dust is improbable in view of the latest researches on the viability of the meningococcus, which show that the organism does not survive long outside the human body. It is more likely that the infection has been again and again introduced into the prisons from the free population outside, or conveyed by carriers present among the prisoners or the officials. In some instances outbreaks among convicts employed in the severe task of canal-digging were attributed to over-exertion and fatigue. The presence of the infection in the Bengal jails, especially those in and around Calcutta, depends probably upon the prevalence of the disease among the general population.* A writer in the *Indian Medical Gazette* in 1902 stated that there is increasing evidence to show that cerebro-spinal fever must be reckoned as one of the continued fevers of India.

In 1906, Captain C. J. Robertson-Milne, I.M.S., who was charged by the Government of India to make inquiry into the behaviour of cerebro-spinal fever in India, formulated the following conclusions:—

(1) Epidemic cerebro-spinal meningitis or cerebro-spinal fever in both its epidemic and sporadic forms is a well known disease in India; the records of the malady show that it is clinically, bacteriologically and epidemiologically identical with the disease as it has been observed in other countries.

(2) In India it has been an ailment which has most frequently attacked prisoners in jails; in some of these institutions the disease has continued to prevail irregularly for prolonged periods. No explanation of this is at present possible. A complete bacteriological and epidemiological study of a severe outbreak, such as has occurred in past years at Bhagalpur and Mung Rasul might be productive of useful data in this connection.†

China.

China is notorious for its reticence regarding the occurrence of epidemic diseases within its borders, the Chinese officials being at all times unwilling to impart information on the subject, especially to the foreign "devils," whose methods for dealing with such diseases are viewed commonly with ill-concealed aversion. It is, however, believed by some medical men who have lived in China that cerebro-spinal fever sometimes occurs there, though facts and figures in support of this opinion are lacking.

In the reports of the Chinese Imperial Customs medical officers‡ in past years occasional reference is made to cerebro-spinal fever and epidemic meningitis. For example, in Dr. H. Rennie Robertson's report on the health of Tientsin for 1900, it is stated

* The Inspector-General of Prisons in 1913 stated that Alipore prison was a modern one, but that the health of this institution largely reflected the state of health of the dwellers in the slums of Calcutta, as, up to November 1st, it had received Calcutta cases only.

† Report on Epidemic Cerebro-spinal Meningitis in India, by Captain C. J. Robertson-Milne, M.B., I.M.S., Calcutta, 1906. Issued under the Authority of the Government of India by the Sanitary Commissioner.

‡ Chinese Imperial Maritime Customs Medical Reports, II.—Special Series No. 2. Published by Order of the Inspector-General of Customs.

that of 18 deaths from all causes among the resident foreigners, three were attributed to "meningitis," and in Dr. W. H. Park's report on Soochow, mention is made of cerebro-spinal meningitis being among the diseases which he had been called upon to treat. A small outbreak of epidemic meningitis occurred in 1901 on board H.M.S. *Redpole* at Kiukiang, one of the Chinese treaty ports on the river Yang-tse-kiang, five members of the crew being attacked within seven days, four of the cases rapidly proving fatal. Two days before this group occurred another member of the crew died suddenly of an acute illness, the nature of which was not stated. Three of the men attacked were sent to the hospital at Hankow. In the report for 1903, by Dr. W. E. Plummer, on the health of Wenchow, a treaty port in the Cheh-Kiang province, it is stated that this district was visited by an epidemic of cerebro-spinal meningitis, nearly all the sufferers being people of the country districts, only a few cases occurring in the town itself. Dr. M. Urbanck, in his report for 1910, on the health of Chinkiang, mentions that he had attended some cases of cerebro-spinal meningitis during the year.

These quotations show that, although little has been heard of cerebro-spinal fever in China, the disease has, nevertheless, occurred from time to time, and has been observed by some of the European medical men practising in that country.

Japan.

Accounts from native sources mention that in the "seventies" there was a severe epidemic of what was apparently cerebro-spinal fever in the interior of Japan between Yokohama and Kioto, but no details are given.*

Not much has been heard of cerebro-spinal fever in Japan during recent years. In 1912, however, there was an outbreak, comprising 347 cases, at Okayama, 560 kilometres from Tokyo. No more details of this occurrence have, however, been obtained.

The Philippine Islands.

During the early years of the American occupation of the Philippines, that is, from 1898 to 1900, cerebro-spinal fever was reported as being present in those islands. Thereafter nothing more was heard of the disease until September, 1912, when a single case was admitted to the General Hospital, Manila. In November, 1913, an outbreak occurred among the labourers in a railroad camp in the Municipality of Laguimanoc, in the province of Tayabas, when about 20 attacks were noted, the diagnosis being confirmed by bacteriological examination. The precise source of this group of cases was never satisfactorily determined, but some Italian workmen and some other men from Cebu having been employed on the railway, it is surmised that some chronic "carrier" among them introduced the disease into the camp. Cases of what was suspected to be cerebro-spinal fever were reported from other

* Dr. Stuart Eldridge, Secretary to the Yokohama Board of Health, in the Medical Reports of the Chinese Imperial Customs, 15th Issue, II., Special Series, No. 2.

parts of the Philippine Islands during 1913, but it does not appear that in these instances there was bacteriological confirmation of the diagnosis. Cases of cerebro-spinal fever have sometimes occurred on board United States ships of war visiting the islands, but, so far as is known, no infection has been conveyed on shore from these vessels to the native population. A single case, however, occurred in Manila harbour in 1913 on board a lighter, the presence of the meningo-coccus being demonstrated on this occasion. There was no evidence of the patient having received his infection from a previous case. During 1914 the disease appeared in several places in the Philippines, and altogether 79 deaths during the year were attributed to this cause.

The Hawaiian Islands.

In 1907 a small group of cases of cerebro-spinal fever occurred in the Hawaiian Islands, but nothing further was reported concerning the disease until 1913, when another small group comprising three cases came under notice at Honolulu, the capital of these islands.

The Fiji Islands.

An epidemic of cerebro-spinal fever occurred in the Fiji Islands during 1885, the incidence of the disease being chiefly upon certain immigrant labourers brought to the Colony from other islands in the Western Pacific. Altogether there were 128 cases and 90 deaths, giving a case mortality rate of 70·3 per cent. This prevalence of the malady lasted five months, and the cases occurred in a number of islands lying far apart from each other, but in constant communication by steamer. Cerebro-spinal fever has been known in the Fiji Islands since 1876, and from that time onwards sporadic cases have come under the notice of the medical men in the colony. Dr. Corney, who reported on the matter,* regarded the occurrence of cerebro-spinal fever in 1885 as an epidemic outbreak of an endemic disease.

New Caledonia.

In a report to the Australian Commonwealth by Dr. Ramsay Smith, published in 1905, on the endemic and epidemic diseases of New Caledonia and the New Hebrides, it is mentioned that an epidemic of cerebro-spinal fever occurred in 1903 among the Kanakas at the native Mission Station of Saint Louis, near Noumea, the capital of New Caledonia. The mortality here was stated to have been high, but the number of attacks and deaths is not given. It is pointed out that the epidemic developed just after a marked prevalence of influenza.

With the exception of this outbreak, there does not appear to be any record of the occurrence of cerebro-spinal fever in New Caledonia.

* Transactions of the Epidemiological Society of London, Vol. VII., 1887-88

Australia.*

New South Wales.—Cerebro-spinal fever has been occuring sporadically in New South Wales for some years; deaths from this cause have been recorded each year since 1900. The following table gives the number of deaths attributed in recent years to cerebro-spinal fever and to meningitis in New South Wales:—

Year.	Deaths from		Remarks.
	Cerebro-spinal fever.	Simple meningitis.	
1900	26	200	——
1901	12	182	——
1902	21	177	——
1903	22	166	——
1904	39	144	——
1905	23	111	——
1906	29	119	5 others from encephalitis.
1907	21	132	4 ,, ,,
1908	24	122	5 ,, ,,
1909	24	118	5 ,, ,,
1910	33	115	17 ,, ,,
1911	28	118	21 ,, ,,
1912	30	126	11 ,, ,,
1913	38†	135	24 ,, ,,
1914	24	—	——
Total ...	394	1,955	——

During 1914, 24 deaths were reported as due to cerebro-spinal meningitis in New South Wales. The majority of the deaths recorded from the malady were of patients under the age of 15 years. The above table shows some fluctuations in the number of deaths ascribed to cerebro-spinal fever, simple meningitis and encephalitis, and it is possible that more than those in the second column were due to meningo-coccal infection.

Queensland.—Since 1898 sporadic cases of cerebro-spinal fever have been reported in Queensland. The deaths from the malady in 1898 numbered four, in 1899 six, in 1900 four, in 1901 six, and in 1902 eight. In 1904, 23 cases and five deaths were recorded, 21 of the cases being patients under the age of 15 years. In the 12 months ended June 30th, 1907, five suspected cases of cerebro-spinal fever came under observation and were investigated bacteriologically, with the result that in only one of them was the meningo-coccus found. In 1908, epidemic cerebro-spinal meningitis became notifiable, but only sporadic cases have been reported since then. In 1913 two suspected cases of cerebro-spinal fever were investigated, one case yielding a positive result.

* The writer wishes to express his thanks to Dr. J. H. L. Cumpston, Director of Quarantine, Commonwealth of Australia, for information respecting the incidence of cerebro-spinal fever in Australia.

† 15 of these were referred to Sydney.

Western Australia.—In the 1913-14 annual report for Western Australia, Dr. James W. Hope, the Chief Medical Officer, states that of late years several sporadic cases of cerebro-spinal fever have been reported, but that in each instance the micro-organism which has been found has not been the meningo-coccus but the micro-coccus catarrhalis. Cerebro-spinal fever became notifiable in Western Australia in 1911.

Victoria.—There is not much information available respecting the occurrence of cerebro-spinal fever in Victoria during past years. In 1910 twelve deaths were recorded, in 1911 eleven, in 1912 seven, in 1913 twelve, and in 1914 seventeen. In July, 1915, the disease became prevalent, and up to October had attacked 470 persons, of whom 34 per cent. died. At the time of writing the epidemic was still proceeding. So far, the source of the infection has not been given. The disease was not made notifiable in Victoria until 1915.

South Australia.—In 1901, 21 deaths from cerebro-spinal fever were recorded in South Australia, and 21 in 1902, in which year the disease became notifiable. In 1903 there were eight deaths from this cause, and in 1904 four. In 1905 and 1906 one death, respectively, was registered, and in 1909 three deaths, but none from that year up to the end of 1914.

From Dr. Cumpston, Director of Quarantine for the Commonwealth of Australia, the information has come that in 1915 there was a considerable prevalence of the disease in Australia associated with the aggregation of men in military camps, those at Brisbane, Sydney, Adelaide, Melbourne, Hobart and Perth having all yielded cases. The chief of these prevalences was at Melbourne, where, up to October, the date of the last communication, cases were being notified daily, the total number of military cases being 167; other attacks were also being reported at the same time among the civilian population.

New Zealand.

So far as can be gathered from a perusal of the annual reports of the Chief Medical Officer for New Zealand, cerebro-spinal fever is seldom seen in that Dominion. From 1904 to 1909 only two deaths were recorded there from cerebro-spinal meningitis. In 1910 two suspected cases were reported, but were not confirmed by bacteriological examination. In 1911 three fatal cases were reported in the Auckland district, and in each instance the bacteriologist found the meningo-coccus present. In the same district in the following year a single case was reported, and in 1913 seven instances occurred. So far as is known, no case was observed during 1914. Prior to 1904, apparently, no deaths were reported from cerebro-spinal fever, but it is possible such deaths may have been classed in the statistical returns under the heading of "other zymotic diseases."

Tasmania.

The notification of cerebro-spinal fever did not become obligatory in Tasmania until 1915, so that there is little information to be had concerning the incidence of the disease in that island.

Three deaths were registered from this cause in 1913 and one in 1914. In 1915 an outbreak was reported, but details at the time of writing are lacking.

South America.

Brazil.—In the past, the scantiness of the records from South American republics concerning mortality and morbidity has prevented any but a rough estimate being made as to the occurrence of cerebro-spinal fever and other communicable diseases in those countries. In the Rio de Janeiro *Annuario de Estatistica Demographo-Sanitària* for the year 1912, deaths from cerebro-spinal fever are not separately recorded. Deaths, however, from "meningite" appear year by year from 1903 to 1912, during which period there was a total of 2,659 deaths attributed to this cause in that city, giving an annual average of 266. The deaths from "meningite" numbered 325 in 1912, and 307 in 1911; the lowest numbers recorded were 215 in 1907 and 219 in 1909.

During 1913, six cases of cerebro-spinal fever were treated in hospital at Rio de Janeiro; and in November of that year the s.s. *Eugenia* arrived at Rio with a number of cases of "meningitis" on board, some persons having died on the voyage. The ship carried 827 passengers, who had embarked at various Mediterranean ports, including Trieste (see also page 151). Among these passengers at least four deaths occurred from "meningitis" after arrival at Rio de Janeiro. During 1914, four fatal cases of cerebro-spinal fever were recorded in that city, but particulars as to the occurrence of non-fatal cases have not been received.

The Argentine.—Little information has reached the Local Government Board as to the occurrence of cerebro-spinal fever in the Argentine. That this disease does occur there not unfrequently is, however, highly probable. During 1914, seven fatal cases were reported in Buenos Aires, the capital. In 1915, three fatal cases had been reported up to May. Coincidently a number of other deaths were certified as due to "meningitis," the number occurring in each month being shown in the following table:—

	Deaths from meningitis in Buenos Aires in 1915.	
	Cerebro-spinal fever.	Simple meningitis.
January ...	—	128
February ...	—	75
March	1	80
April	1	69
May	1	13

The decrease in the first half of the year of deaths from simple meningitis from 128 in January to 13 in May, and the actual occurrence about the same time of cases diagnosed as cerebro-

spinal fever, suggest the probability that of the deaths attributed to simple "meningitis," some at least were due to cerebro-spinal fever.

Uruguay.—There is little information as to the degree of incidence of cerebro-spinal fever in the Republic of Uruguay. In Montevideo, its capital, from 1909 to 1913, 29 deaths were attributed to this disease. In May, 1915, five deaths were recorded from this cause in Montevideo. How far this represents all the fatal cerebro-spinal fever cases which occurred in the city it is not possible to say, for each year a number of cases are recorded from "meningitis" and others from "encefalitis." From 1909 to 1913, 1,429 deaths from meningitis were reported in Montevideo, an annual average of 286. Owing to the difficulties of diagnosis in many cases, bacteriological test being unavailable, it is possible that some deaths attributed to "meningitis" may have been caused by cerebro-spinal fever.

Peru.—During 1910 several cases of cerebro-spinal fever occurred among soldiers stationed at Lima and Callao, but the number of attacks has not been stated. It is now regarded as extremely probable that this disease has long existed in Peru, though not recognised till comparatively recently; some of the deaths ascribed to tuberculous meningitis, and some to a severe type of typhoid fever, as also to influenza, may have been due to cerebro-spinal fever.

From other republics in South America, such as Chili, Bolivia, Ecuador, Colombia and Venezuela, no information has been available concerning the incidence of cerebro-spinal fever; but the absence of recorded facts cannot be taken to mean that this disease has not been manifesting itself in these States during recent years.

Central America.—Information concerning the incidence of infectious diseases in any of the small republics of Central America is sparse and fragmentary. The only reference to the recent occurrence of cerebro-spinal fever in this region comes from the republic of San Salvador, and is to the effect that towards the end of 1913 five deaths from the disease were recorded at Acajutla, a small seaport town on the west coast of that State.

The West Indies.

Jamaica.—Cerebro-spinal fever occurs from time to time in Jamaica. During an investigation which recently took place as to the incidence of a disease often prevalent in Jamaica, and known locally under the name of "vomiting sickness," it was found that the malady so named includes several different diseases—among them, cerebro-spinal fever, the presence of the meningo-coccus in several fatal cases having been clearly demonstrated by the Government bacteriologist. During the first four months of 1913 five such deaths were reported, but information as to the number of non-fatal cases has not been received.

Cuba.—"Meningitis" is a comparatively common cause of death in Cuba. In 1911, out of a total of 32,061 deaths from all causes, 794 were attributed to meningitis, but it is not clear whether under this heading are included deaths from cerebro-

spinal fever. This disease is, however, sometimes imported. In 1911, for instance, a ship from Spanish and Italian ports is known to have landed at Havana a man suffering from cerebro-spinal fever.

Porto Rico.—Cerebro-spinal fever was prevalent among the black population of the island of Porto Rico during 1902–3, and 253 deaths resulted from the disease in that period. The malady lingered on during 1903-4, when 33 more deaths were recorded from it. Since then little has been heard of cerebro-spinal fever in the island, except that two cases and one death were reported in the summer of 1914.

Mexico.

For some years fatal cases of cerebro-spinal meningitis have been recorded in the "Boletin de Consejo Superior de Salubridad," the monthly official organ which contains the returns of mortality for the City of Mexico, the present population of which is about 450,000. The following table gives the number of deaths reported in each year from this disease and from simple meningitis in the City of Mexico from 1902 to 1908, and also those recorded since 1905 from "encefalitis": —

Year.	Cerebro-spinal meningitis.	Simple meningitis.	Encefalitis.
1902 ...	31	490	—
1903 ...	23	444	—
1904 ...	22	485	—
1905 ...	28	482	20
1906 ...	20	459	14
1907 ...	5	541	17
1908 ...	27	851	17

Unfortunately the records for 1909, 1910 and 1911 are missing, so that the table cannot be continued to include those years, but it is obvious that an epidemic, characterised by meningeal symptoms, was developing when the deaths from meningitis rose from 459 in 1906 to 541 in 1907 and to 851 in 1908.

In 1912, 60 deaths were reported from "cerebro-spinal fever" in the City of Mexico, 551 from simple meningitis and 12 from encefalitis; and in 1913 the figures were 138, 485 and 9, respectively. In January and February, 1914, 25 deaths from cerebro-spinal fever were recorded, but, owing to the disturbed internal state of the republic, the official reports of the City of Mexico have not reached this country since that date.

In Vera Cruz, the principal port of Mexico, situated on its eastern coast, 235 miles from Mexico City, and having a population of about 45,000, cerebro-spinal fever was prevalent during the second half of 1913, 35 deaths being reported from it. The infection, it is stated, was introduced into Vera Cruz by troops from Mexico City, and the disease spread subsequently in several of the barracks at Vera Cruz. Cerebro-spinal fever continued to be prevalent in Vera Cruz during the spring months of 1914,

during which period 18 more deaths were reported, mostly among the military. For the reasons already stated, no further information since then has been available as to occurrences of cerebro-spinal fever in Mexico.

United States of America.

For many years epidemic cerebro-spinal meningitis has been manifesting itself in the United States, and outbreaks of considerable dimensions have occasionally been reported. It is stated that in the United States the malady is largely a disease of cities, not of rural districts. Dr. Sophian, an American authority upon the subject, says that the disease can be found in sporadic form in nearly all the large cities of the United States, more especially during cold weather. Sir William Osler refers to the disease as having been present among the forces of the rival armies of the North and South during the American Civil War in the early sixties. The State of New York, after suffering year by year a number of deaths from this cause, experienced the development of a serious epidemic in 1893, and again in 1904–5. A large proportion of the fatal cases in this State are referred, as will be seen later, to the City of New York and those of its suburbs which are included in the so-called maritime district of New York State. This district comprises Greater New York, Long Island and Westchester County, and contains more than half of the population of the State. The following table gives the number of deaths attributed to cerebro-spinal meningitis from 1885 to 1907 in the State of New York (population at the Census of 1905, 8,198,500), and the number also of deaths from the disease in the Maritime District of the State (population 4,523,940).

New York State.—Deaths from Cerebro-spinal Fever.

Year.	State.	Maritime district.	Year.	State.	Maritime district.
1885	446	233	1897	541	332
1886	572	246	1898	695	401
1887	540	232	1899	702	414
1888	490	201	1900	531	310
1889	392	243	1901	492	257
1890	482	170	1902	456	264
1891	687	311	1903	454	271
1892	653	364	1904	1,708	1,432
1893	853	652	1905	2,566	2,142
1894	502	254	1906	1,178	846
1895	539	335	1907	225	*
1896	513	291			
Total in 12 years	6,669	3,532	Total in 11 yrs.	9,548	6,669

City of New York.—There were four recognised outbreaks of epidemic cerebro-spinal meningitis in the City of New York during the 40 years ended 1905, namely, in 1872 (782 deaths), 1881 (461 deaths), and 1893 (469 deaths); the fourth outbreak in

* Figures for 1907 not obtained.

1904–5 was the worst, the total mortality from the disease during the two years amounting to 2,594. Including the suburbs, 1,403 deaths occurred in Greater New York in 1904, and 2,026 in 1905, making for the two years no fewer than 3,429 fatal cases in the city and its environs. From the official reports of the Department of Health for New York City, it appears that the winters of 1872, 1881, 1893 and 1904 were "hard winters" attended with intense cold and much snow. The last of these four epidemics was carefully investigated by a commission of experts, who found that the disease was most prevalent among the poorer people in New York, and that it occurred most frequently in the more densely populated districts of the city, where overcrowding and bad ventilation were common. Of 2,180 cases subjected to investigation 1,476, or 67·7 per cent., were under ten years of age; 409, or 18·8 per cent., were aged from 10 to 20; and 295, or 13·5 per cent., over 20 years of age. Of the total 2,180, 1,170 were males, 999 females; in 11 instances the sex was not stated. Some cases diagnosed as cerebro-spinal fever were found, after bacteriological examination, to be tuberculous meningitis, or simple meningitis, and *vice versa*. The case-mortality rate in this epidemic was stated to be 73·5 per cent. As regards eruptions, 425 cases had a petechial rash, and 235 a herpetic, but many had no rash at all.

In the following table are recorded the number of deaths in the City of New York from epidemic cerebro-spinal meningitis, tuberculous meningitis, and simple meningitis, respectively, during the 40 years' period 1866 to 1905. (The population of the City in 1872 was 968,710; in 1881, 1,244,511; in 1893, 1,758,011; and in 1905, 2,390,382):—

Deaths recorded in the City of New York.

Year.	Epidemic cerebro-spinal meningitis.	Tuberculous meningitis.	Simple meningitis.	Year.	Epidemic cerebro-spinal meningitis.	Tuberculous meningitis.	Simple meningitis.
1866 ...	18	588	486	1886...	223	721	872
1867 ...	33	654	674	1887...	203	621	952
1868 ...	34	627	820	1888...	173	493	914
1869 ...	42	688	725	1889...	145	543	839
1870 ...	32	812	750	1890...	136	556	856
1871 ...	48	755	623	1891...	189	583	932
1872 ...	782	770	848	1892...	230	605	1,020
1873 ...	290	682	666	1893...	469	607	1,160
1874 ...	158	627	563	1894...	213	598	926
1875 ...	146	599	643	1895...	204	585	871
1876 ...	127	613	697	1896...	178	511	784
1877 ...	116	514	556	1897...	232	517	755
1878 ...	97	604	569	1898...	258	593	782
1879 ...	108	609	536	1899...	287	609	742
1880 ...	170	617	583	1900...	201	585	544
1881 ...	461	675	764	1901...	201	501	569
1882 ...	238	659	714	1902...	190	571	633
1883 ...	223	541	719	1903...	195	566	448
1884 ...	210	683	797	1904...	1,083	470	588
1885 ...	202	639	844	1905...	1,511	*	*

* Figures not obtained.

The result of studies made in the Research Laboratory of the Health Department of the city in 1904–5 showed that half of the persons ill of cerebro-spinal fever harboured the meningo-coccus in the naso-pharynx during the first week of illness. After the second week this organism was found in the naso-pharynx less frequently, though in some instances it persisted for an indefinite period. In the City of New York, from 1911 to 1914, 1,132 cases of cerebro-spinal fever were reported, and of these 821, or 72·5 per cent., died. These figures are, however, admittedly incomplete. During the first six months of 1915, 144 deaths from the disease were recorded, but the number of attacks has not yet been published.

It is worth mention that, in 1912, 18 alien passengers were landed in New York suffering from "meningitis," of whom six died. The ships on which these immigrants arrived had come mostly from Mediterranean ports, and several of the persons attacked were of Greek nationality.

The State of Massachusetts (population in 1900, 2,805,000), like that of New York, has suffered in the past from epidemic cerebro-spinal meningitis. In 1873 the deaths attributed to this disease in the State amounted to 747. In the 20 years' period ended October 31st, 1897, 2,909 deaths from this cause, or an annual average of 145 fatal cases, were recorded in Massachusetts; but during 1897 557 fatal cases were reported, 184 of which were referred to the city of Boston. This outbreak was investigated by three expert physicians,* whose report furnished much valuable information concerning the disease from the clinical and bacteriological points of view. The age incidence of the malady in the cases observed in the State from 1887 to 1895 is given in tabular form in the above-mentioned report, and the chief points are here reproduced:—

Massachusetts—Deaths from Cerebro-Spinal Fever, 1887-1895.

Age periods.	Males.	Females.	Total.
Under one year	180	136	316
1–2 years ...	74	72	146
2–3 ,, ...	51	48	99
3–4 ,, ...	41	36	77
4–5 ,, ...	19	19	38
5–10 ,, ...	59	73	132
10–15 ,, ...	47	34	81
15–20 ,, ...	36	25	61
20–60 ,, ...	89	97	186
Totals ...	596	540	1,136

* Epidemic Cerebro-spinal Meningitis, and its Relation to other forms of Meningitis, by Dr. W. T. Councilman, Professor of Pathological Anatomy, Harvard University, and Pathologist to the City Hospital, Boston; Dr. F. B. Mallory, Pathologist to the Children's Hospital, Boston; and Dr. J. H. Wright, Director of the Laboratory of the Massachusetts General Hospital, Boston, 1898.

From this table it will be seen that 889 of these deaths from the malady, or 78·3 per cent. of the whole, were at ages under 15 years. It is stated that 95 per cent. of the cases occurred in the larger towns of the State.

The deaths recorded since 1896 in Massachusetts from cerebro-spinal fever are shown in the subjoined table:—

——	1897	1898	1899	1900	1901	1902	1903	1904
Deaths ...	557	471	393	385	352	165	339	297

——	1905	1906	1907	1908	1909	1910	1911	1912
Deaths ...	560	368	530	253	225	213	202	213

This table affords evidence that in the State of Massachusetts the number of deaths recorded from this malady has decreased in recent years.

The State of Indiana.—Among other North American States which have suffered in the past from epidemics of cerebro-spinal meningitis may be mentioned Indiana, which had 347 deaths in 1904, 460 in 1905, and 481 in 1906, a total of 1,288 for the three years' period, in a population of about 2,700,000.

The State of Michigan.—In the past there has been some diversity of nomenclature respecting what was presumably cerebro-spinal fever in some of the States of North America. For instance, in Michigan, from 1869 to 1875, the annual records of vital statistics show a number of deaths as due to cephalitis, or inflammation of the brain, meningitis, spinal meningitis, cerebro-spinal meningitis, spinal fever and spotted fever. The following table gives the number of deaths reported under these various headings in the State of Michigan (population, census of 1874, 1,334,031) from 1869 to 1875:—

Year.	Cephalitis or inflammation of the brain	Spinal fever.	Spotted fever.	Cerebro-spinal meningitis	Spinal meningitis	Meningitis	Total of the various forms of meningitis
1869 ...	226	—	5	—	6	2	239
1870 ...	233	—	8	1	1	1	244
1871 ...	216	1	16	7	2	3	245
1872 ...	330	112	109	79	47	13	690
1873 ...	333	428	66	145	166	7	1,145
1874 ...	261	89	6	33	50	7	446
1875 ...	232	74	4	36	38	14	398
Total ..	1,831	704	214	301	310	47	3,407

In former years cerebro-spinal fever was sometimes reported in America as "typhoid meningitis," "malignant meningitis," and occasionally as "petechial fever"; while, at one time, it was proposed to term it "tetanoid fever." With this diversity of names in the past for probably one and the same disease, it is possible that the true dimensions of some of the reported epidemics of cerebro-spinal fever in the United States have not been accurately ascertained; also, it is officially admitted that not infrequently cases of the disease have been in former years wrongly diagnosed as tuberculous meningitis. At the present day such mistakes are less likely to occur, more especially where competent bacteriological assistance is available.

Owing to the increasing number of deaths attributed to meningitis in Michigan, the State Board of Health began to study meningeal cases, and in 1907 a report on the subject was included in the annual summary of the State's vital statistics. The subjoined table gives the number of deaths ascribed to meningitis and tuberculosis meningitis in Michigan from 1899 to 1907. It is obvious that, at the time when the statistical study was begun, some epidemic influence had been antecedently at work. The population of the State of Michigan in 1901 was 2,448,241.

State of Michigan.

Year.	Deaths from	
	Meningitis.	Tuberculous meningitis.
1899 ...	1,079	41
1900 ...	688	83
1901 ...	594	86
1902 ...	598	94
1903 ...	630	106
1904 ...	586	133
1905 ...	646	107
1906 ...	627	106
1907 ...	670	86
Total ...	6,118	842

The deaths from meningitis in Michigan were found to be most numerous in the larger centres of population. The precise ages were ascertained in 6,052 instances, and of these 5,475, or 90·5 per cent., were under the age of 15 years, and 3,417 of this number had not reached the age of five years.

During 1910 there were 387 reported cases of the disease in Michigan.

In the State of Ohio, which had a population of 2,420,982 at the census of 1900, deaths from cerebro-spinal meningitis have

been not uncommon for some years, as may be seen in the appended table:—

Cerebro-spinal meningitis.	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906
Deaths ...	149	207	286	581	278	262	217	283	119	118	81

The City of Chicago (in the State of Illinois), like some other American cities, has for a long series of years suffered from cerebro-spinal fever, though the deaths from the disease have not all been returned under that heading. There was an outbreak in 1872, and in that year 300 fatal cases were reported; during 1872 and 1873 there was also a marked increase in the number of deaths recorded under "meningitis" and "convulsions." This is shown in the subjoined table:—

Chicago.

Year.	Deaths from—			
	Cerebro-spinal meningitis.	Meningitis.	Encephalitis.	Convulsions.
1870	31	111	96	723
1871	42	96	79	652
1872	300	230	146	1,012
1873	129	149	91	1,142

In 1874 the deaths reported in Chicago from convulsions fell to 971, and by 1878 they had still farther fallen to 729. From 1886 to 1894 the mortality returns for Chicago showed a gradually increasing number of deaths from cerebro-spinal meningitis, and, concurrently, the numbers recorded from "meningitis" and "convulsions" showed a similar increase, leading to the suggestion that perhaps some of the reported deaths under these two headings were due to epidemic cerebro-spinal meningitis. The appended table gives the number of deaths from 1886 to 1906 returned in Chicago from (1) cerebro-spinal meningitis; (2) meningitis; (3) encephalitis; and (4) convulsions.

The table has been compiled from the various statistical returns included in the Annual Reports of the Department of Health of the City of Chicago:—

Chicago.

Year.	Deaths from			
	Cerebro-spinal meningitis.	Meningitis.	Encephalitis.	Convulsions.
1886	103	319	45	1,021
1887	81	402	79	996
1888	138	363	69	1,012
1889	110	436	70	1,082
1890	142	479	94	1,263
1891	301	671	90	1,627
1892	223	635	64	1,560
1893	388	519	111	1,326
1894	249	533	*	1,189
1895	8	910	*	1,113
1896	2	825	*	938
1897	—	795	*	741
1898	17	883	*	646
1899	18	807	*	667
1900	6	685	*	641
1901	9	628	*	667
1902	4	687	*	651
1903	1	678	*	618
1904	4	438	*	553
1905	16	422	*	516
1906	6	445	*	461

The population of Chicago in 1870 was 306,605; in 1880 it had risen to 503,185; in 1890 to 1,099,850; in 1900 to 1,698,575; and in 1910 to 2,195,551. The above table shows that, during increasing prevalence of cerebro-spinal fever, deaths from "meningitis" and from "convulsions" displayed a considerable augmentation, the fatal cases under the latter class rising from 996 in 1887 to 1,627 in 1891. It is, no doubt, possible that this co-incident rise in the mortality from cerebro-spinal meningitis and convulsions may have been due to different causes, as, for example, to the epidemic prevalence of measles and whooping-cough, which are known to increase the mortality in young children from "convulsions." It is at least worthy of notice that what happened in the epidemic of 1872-73 occurred again in 1889-94; lending, perhaps, some support to the view that deaths in young children from cerebro-spinal fever may have been returned as due to convulsions.

With the practical disappearance of cerebro-spinal fever from the city records, from 1895 to 1906 the deaths returned from "convulsions" fell considerably, and by 1906 the number was only 461, as compared with 1,627 in 1891 and 1,560 in 1892. Notwithstanding the sudden decrease of deaths from epidemic cerebro-spinal meningitis in 1895, the fatal cases reported from

* From 1894 onwards the deaths ascribed to "encephalitis" were included under meningitis.

"meningitis" increased from 533 in 1894 to 910 in 1895 and 825 in 1896. The annual number continued high until 1900, after which it gradually fell until 1906, when only 445 deaths were recorded; the number was further reduced in 1909 to 263. In 1909, under a system of notification by medical men, 33 cases of "cerebro-spinal fever" were reported, and, in 1910, 64.

Fifty-eight deaths from epidemic cerebro-spinal meningitis were reported during 1913 in Chicago and 47 in 1914.

The State of Georgia.—A local outbreak of cerebro-spinal fever occurred in 1911 at Savannah in the State of Georgia, which was officially investigated by one of the medical officers of the United States Public Health Service. The population of Savannah is 65,064, of which negroes constitute 52 per cent. The outbreak began in January, 1911, and, up to March, 81 cases and 46 deaths were reported. Of those attacked 19 were white and 62 negroes. Of 34 suspected cases submitted to bacteriological examination 32, or 94·1 per cent., yielded the meningo-coccus. Anti-meningo-coccal serum is said to have been employed at Savannah with beneficial results.

The State of Texas.—At the end of 1911 the disease was prevalent in the State of Texas, and 239 cases with 107 deaths were reported at the town of Dallas from October, 1911, to January, 1912. Among the contacts there it is stated that 50 per cent. were found to be carriers though showing no signs of illness. At Fort Wort, in this State, 61 persons were attacked about the same period and 25 died; and at Waco 119 more cases and 44 deaths came under observation. Including some attacks in smaller numbers in other parts of Texas, the total number reported in the State from October, 1911, to January, 1912, was 500, of which 210 terminated fatally.*

Other States.—Cerebro-spinal fever was also prevalent in the State of Oklahoma from December, 1911, to the end of March, 1912, during which period 415 cases and 159 deaths were recorded. The disease also appeared in Kansas, but in smaller amount. In the State of Missouri, during 1912, 486 deaths were attributed to cerebro-spinal fever.

Sporadic cases occurred in various other States during the latter half of 1912, the largest groups of attacks occurring in Arkansas, Tennessee, and Illinois. One group at Lapanto, in Arkansas, comprised 25 cases and 17 deaths; while in Tennessee up to January, 1913, 108 attacks with 47 deaths had been recorded.

The above do not include all the States which have suffered from cerebro-spinal fever in past years, but the examples given will serve to show the widespread distribution of the disease throughout the American Union.

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* Annual Report of the Surgeon-General of the Public Health Service of the United States for the fiscal year 1912.

During 1913 and 1914, as will be seen from the subjoined table, the disease was still prevalent in a number of States:—

Cerebro-spinal fever cases and deaths reported in the United States during 1913 *and* 1914.

—	Population, July 1st, 1913.	1913.		1914.	
		Cases.	Deaths.	Cases.	Deaths.
Alabama	2,238,614	171	110*	—	—
Arizona	230,808	54	42‡	8	†
California	2,667,516	67	49	70	40
Connecticut	1,181,793	31	23	31	20
District of Columbia ...	348,077	4	3	8	5
Illinois	5,904,043	177	111	196	80
Indiana	2,760,792	70	50	74	74
Iowa	2,222,472	54	54*	50	31
Kansas	1,762,573	36	8	31	†
Maryland	1,330,209	87	86	39	†
Massachusetts	3,548,705	178	†	21	12
Minnesota	2,181,077	18	11*	—	—
Montana	419,174	104	88*	77	65
Nebraska	1,233,122	†	86	—	—
Nevada	94,722	11	10	—	—
New York	9,712,954	333	307	446	360
Oklahoma	1,938,761	†	90	—	—
South Carolina	1,572,285	32	†	19	†
South Dakota	643,121	8	3	55	46
Utah	404,735	†	38	†	12
Washington	1,344,686	47	35*	23	23
Wisconsin	2,419,898	519	411	416	341
Wyoming	163,325	19	11	2	2
Louisiana	1,656,388‖	—	—	66	22
Mississippi	1,797,114‖	—	—	61	13
Ohio	4,767,121‖	—	—	201	†
Oregon	756,988	—	—	5	1

The above table is compiled partly from the returns published in the Annual Reports of the United States Public Health Service; but, besides the cases and deaths recorded in 23 States for 1913, the disease is believed to have been present in a number of other States from which no reports had been furnished.

From these incomplete figures it appears that at least 2,030 cases occurred in 1913 and 1,626 of them proved fatal; in 1914 the attacks amounted to 1,899, and of these 1,117 had a fatal termination. Since the figures are known to be imperfect any rates calculated upon them would be misleading.

* These returns are admittedly incomplete, and do not therefore represent the real incidence of the disease.

† The figures have not been supplied.

‡ Six months only.

‖ Population in 1910.

Canada.

There can be little doubt that in past years cerebro-spinal fever has occurred from time to time in Canada, though no outbreaks of any great dimensions have been reported. In 1871 the disease was certainly present in Montreal, and, in the annual reports of the medical officer of health for that city, deaths from cerebro-spinal meningitis continued to be recorded from year to year. In the reports from 1884 to 1892 the following fatal cases were reported, as also a much larger number attributed to "cephalitis" or encephalitis. The population of Montreal in 1887 was 189,051:—

Montreal.

Year.	Deaths from		Remarks.
	Cerebro-spinal meningitis.	Encephalitis.	
1884 ...	16	179	—
1885 ...	31	291	—
1886 ...	20	218	—
1887 ...	17	240	—
1888 ...	23	285	Including 282 under the age of 5 years.
1889 ...	18	341	Including 267 under the age of 5 years.
1890 ...	16	360	—
1891 ...	10	324	—
1892 ...	19	332	—

The reports for 1893 and 1894 are not available, but in 1895 14 deaths were recorded from cerebro-spinal meningitis and 284 from meningitis; in 1896 the corresponding figures were 18 and 296.

In recent years fatal meningeal maladies in Montreal have been recorded under headings as follows:—Encephalitis, simple meningitis, epidemic cerebro-spinal meningitis and tuberculous meningitis. The City of Montreal, at the census of 1911, had a population of 466,200.

Montreal.

Year.	Deaths from			
	Encephalitis.	Simple meningitis.	Epidemic cerebro-spinal meningitis.	Tuberculous meningitis.
1910	4	367	21	71
1911	10	270	23	76
1912	6	289	26	67
1913	3	294	36	68

It appears from this table that while the deaths ascribed to tuberculous meningitis remained fairly even during the four years 1910–13, those recorded from simple meningitis fell from 367 in 1910 to 270 in 1911, a difference of nearly 100, and that meanwhile deaths from cerebro-spinal meningitis increased some 70 per cent. This suggests the possibility that some of the deaths formerly reported as simple meningitis have been due to the meningo-coccal infection. It is probable, indeed, that cerebro-spinal fever is endemic in Montreal, as in some other of the large cities of North America.

Effort was made to find record of other Canadian cities and provinces as to epidemic cerebro-spinal meningitis of late years, but in the reports which were examined little direct information on the subject was found. These reports refer for the most part to the commoner infections, such as smallpox, typhoid fever, scarlatina, diphtheria, measles and tubercle, and "other infections" or "other zymotic diseases." It is not unlikely that cerebro-spinal fever deaths have been included under the two latter headings. In the Province of Ontario, during 1914, 68 cases and 55 deaths were recorded. Clemow, in his "Geography of Disease," mentions that in Alaska cerebro-spinal fever is not uncommon, and that it is spoken of as one of the many dangers inseparable from the gold-mining industry in the remote and inhospitable region of the Yukon Valley.

Report to the Local Government Board on the Provision of Midwifery Service in the County of London, by Janet E. Lane-Claypon, M.D., D.Sc.

ARTHUR NEWSHOLME,
Medical Officer,
January 24th, 1917.

INTRODUCTION.

In accordance with instructions received from the Board an investigation into the existing provision and conditions of midwifery work in the metropolitan area has been carried out.

The investigation includes a statistical study of the number of births attended by the different agencies at work. These four main agencies are:—

(*a*) The private practitioner;
(*b*) Private midwives;
(*c*) Medical schools attached to hospitals;
(*d*) Hospitals and other institutions undertaking the training of midwives.

In order to obtain the information required I have visited—

(*a*) The Medical Officer of Health of each metropolitan borough;
(*b*) All the hospitals or other voluntary institutions concerned with the provision of midwifery;
(*c*) A number of midwives working in branch establishments of the above;
(*d*) Thirty-three independent midwives residing in 23 out of the 29 metropolitan boroughs; and
(*e*) A few private practitioners.

In this investigation I have received assistance of the utmost value from the officers of the London County Council, who not only allowed me access to their inspectors of midwives and through them to the independent midwives, but also prepared much statistical information upon matters connected with the midwifery work of midwives.

I should like to express my indebtedness, and also my gratitude, to the borough Medical Officers of Health, secretaries, almoners, matrons and ward sisters of hospitals, superintendents of institutions, as also to other private persons and midwives for the unfailing courtesy with which they granted my requests for interviews and supplied me with the required information, frequently at considerable personal labour and trouble. The Report has been divided into eight sections:—

A.—A STATISTICAL SURVEY OF THE NUMBER OF BIRTHS ATTENDED IN THE YEAR 1915, BY THE VARIOUS MIDWIFERY AGENCIES WORKING IN THE COUNTY OF LONDON.

(4688.) Wt. 41492—365. 875. 3/17. J. T. & S., Ltd. G. 14.

B.—In-Patient Maternity Work in the Metropolitan Area.

C.—Out-Patient Maternity Work Connected with Institutions.

D.—Midwifery Work in the Home by General Practitioners.

E.—The Work of Independent Midwives in the Metropolitan Area.

(*a*) Statistical notes.
(*b*) General arrangements.
(*c*) Fees.
(*d*) Booking and ante-natal work.
(*e*) Attendance at the confinement and the provision of medical aid for emergencies.
(*f*) Maternity nursing.

F.—Economic Considerations upon the Work of a Midwife.

G.—Notes on the Maternity Benefit.

H.—Conclusions.

Appendix A.—Notes on the midwifery work of the twelve Medical Schools of London.

Appendix B.—Notes on the work of institutions other than the above which provide a midwifery service, whether for in-patient or out-patient work.

SECTION A.

A Statistical Survey of the number of Births attended in the year 1915 by the various Midwifery Agencies in the County of London.

Since the Midwives' Act of 1902 came into operation only two classes of persons are legally allowed to practice midwifery, namely, doctors and registered midwives. Both doctors and midwives undertake this work as a means of livelihood, although in the case of the doctors it forms usually only a small part of their whole work. In addition to those who practice independently some doctors and midwives work as salaried officers of institutions.

In London, the institutions are responsible for a greater share of the midwifery work of the county than is the case in other areas. These institutions may undertake two forms of service, *i.e.*, in-patient work at the institution, and out-patient work in the homes of the people. These two branches of work may be served either by doctors or midwives, or by both. In nearly every case the institution is a training school either for doctors or for midwives, and the service is conducted either by medical students or by pupil-midwives working under trained midwives, or sometimes by both.

In order to ascertain the number of births attended respectively by private doctors and midwives, and by institutions, it has been necessary to have recourse to several sources of information. The two main official sources of information are the Registrar-General's figures and the figures in the possession of the medical officers of health of the metropolitan boroughs, obtained through the notification of births.

The figures of the Registrar-General serve for the present purpose as a valuable check, but convey no information as to the nature of the attendance at birth.

The figures obtained from the medical officers of health form the main source of information, although it has been necessary to obtain supplementary information from the institutions themselves in regard to the births attended in or from institutions.

Under the Notification of Births Act of 1907 it is the duty of the father of the child, or of any person in attendance on the mother at, or within, six hours of the time of birth, to notify the fact of the birth within 36 hours after its occurrence to the medical officer of health for the district in which the birth has occurred. Special forms for this purpose are supplied to all doctors and midwives practising in the area.

Independent midwives appear almost universally to sign the form themselves, and the number of notification forms received from these midwives may be taken as an accurate figure of the number of births attended by them. Lists of the midwives practising in each borough are supplied by the London County Council (to which body midwives must notify their intention of practising

in the County of London) to the medical officer of health of the borough or boroughs concerned. The names of the midwives are therefore known to the Public Health Department and there is no difficulty in allocating the births attended by them. Lists of the notified births are also forwarded to the London County Council by the medical officers of health, and that body also sorts the notifications according to the nature of the attendance, with special reference to the cases attended by midwives.

Doctors frequently notify the cases themselves, but some practitioners hand the notification form to the parent or other person present at the birth, who signs the form and sends it to the medical officer of health. In these cases there is nothing on the form to show the person who has attended the birth. These births are classed together as being notified by "parents and others." Experience, however, leads to the belief that a very large proportion, probably nearly all the births falling into this category, have been attended by doctors.

Midwives connected with institutions for the most part sign the notification form themselves. Medical students seem usually to sign the forms themselves, although it appears that sometimes they hand it to the parent.

One maternity institution makes a practice of handing the form to the parent and in this case an adjustment of the figures has been made for the borough concerned.

Considerable difficulty has, nevertheless, been experienced in ascertaining the number of births attended either by medical students or pupil-midwives in the different boroughs, since most institutions work in more than one borough. It has been necessary to compare the total figures given in the reports of the institutions with those supplied by the medical officers of health of the various boroughs in which the institution works. In some cases the figure for a borough has been obtained by subtracting from the total figure given by the institution, the figures for the boroughs in which the number of cases attended was available. It was then assumed that the remaining figure represented the number for the borough from which figures were not directly available. Several institutions have kindly supplied the information directly by reference to their registers. The figures now put forward are believed to be substantially correct for all the boroughs.

The most complicated procedure is connected with births occurring in institutions. These are all notified to the medical officer of health of the borough in which the institution is situated, without regard to the place of residence of the mother. In most hospitals a large proportion of the in-patients are not residents of the borough in which the hospital lies. The medical officer of health retains only the notifications of such births as are residents in his borough and forwards the other notifications, either directly or through the London County Council, to the medical officer of health of the borough or boroughs concerned. The allocation of these births to the proper district has been accomplished through the kindness of numerous persons, and the error is believed to be negligible. Table I., showing the apportionment of the births for the year 1915, has been prepared from

the sources above-mentioned. In-patient births have not been inserted owing to the complexity of their distribution, but are considered fully in Section B.

Column I. shows the corrected figures of the Registrar-General for the births in each borough.

Column II. shows the total number of notifications received by the medical officers of health for the different boroughs.

(It may be noted that the figure in this column is usually below that in Column I. This is believed to be in part due to non-notification, usually of the births in well-to-do families. In some cases, however, the figure is higher in the second column, as in St. Marylebone, Stepney, Lambeth and Hackney. This is due to the notifications received from in-patient institutions of births of non-residents which have been transferred in the corrected figures prepared by the Registrar-General to their proper districts.

Columns III., IV., V., VI. show the figures for births attended as out-patients from institutions arrived at after comparison and subsequent adjustment of the information supplied both by the institutions and by the medical officers of health. The majority of these births were notified. In Column VI. the percentage has been worked out on the *corrected registered* figures, since this gives a more accurate result than would be obtained by taking the *notified* births.

Column VII. shows the total number of notifications signed by doctors.

Column VIII. shows the same for the independent midwives, including cases where the midwife attends on behalf of an institution for the payment of a fixed fee (for details see pp. 33, 34).

Column IX. shows the notification of births received by the medical officers of health where the signature did not enable the nature of the attendance at birth to be identified. As already stated, these may almost certainly be assigned to doctors.

The table shows that 101,649 births occurred among residents in the county of London, and that 97,451 notifications of births were received. The actual deficit due to non-notification, however, exceeds the difference between these two numbers, because a certain number of births of non-residents also occurred in the county. These births appear, or should appear if all were notified, among those in Column II., but do not appear among the corrected births in Column I. (for further details see page 11).

The percentage of total births registered which are attended at home from institutions, show such extreme divergences in the different boroughs as to render it almost impossible to suppose that the demand for assistance of a charitable nature has created the supply. The reverse seems to have occurred, and the figures suggest that the institutional aid has at least in some degree, been due to the necessity for providing training for medical students and midwives. In the adjacent boroughs of Stepney and Poplar,

TABLE I.

Name of borough.	I. Births registered.	II. Births notified.	Births attended from institutions. III. 1. By medical students.	IV. 2. By mid-wives.	V. 3. Total.	VI. 4. Percentage of all registered births.	VII. Births notified by doctors.	VIII. Births notified by inde-pendent mid-wives.	IX. Births notified by parents and others.
Bethnal Green	3,514	3,308	(1) & (2) cannot be separated.		993[a]	28·2	975	1,204	56
City of London	150	114	4	2	6	4·0	72	18	7
Chelsea	1,099	897	117	112	229	20·5	248	259	0[g]
Finsbury	2,198	2,262	853	307	1,160	52·7	126	139	223
Fulham	3,870	3,177	0	0	0	0·0	648	2,386	143
Hammersmith	2,707	2,346	0	0	0	0·0	851	1,210	152
Hackney	4,844	5,080	0	1,072	1,072	22·1	2,524	1,095	0[g]
Hampstead	1,317	1,177	0	30	30	2·2	294	193	642
Holborn	672	531	150	128	278	41·4	141	78	12
Islington	7,544	6,483	364[b] approx.	664	1,028	13·6	1,470	3,265	720
Kensington	3,118	2,892	8[c]	1,015	1,023	32·5	545	1,212	112
Paddington	2,746	2,498	0[c] (since 1914.)	518	518	18·1	947	485	478
Poplar	4,742	4,648	0	535	535	11·2	1,274	2,640	0[g]
St. Marylebone	1,823	3,682	114	882	996	54·6	375	175	212
St. Pancras	4,755	4,131	1,163[a]	607	1,770	37·2	223	956	1,672
Shoreditch	3,114	2,748	0	1,159	1,159	37·2	731	847	0[g]
Stepney	7,512	7,819	1,878	1,166	3,044	40·4	1,834	1,519	61
Stoke Newington... ...	916	794	0	0[d]	0	0·0	526	268	0[g]
Westminster	1,969	1,292	402	85[e]	487	24·7	236	303	170
Battersea	3,824	3,301	0	352	352	9·2	504	1,152	1,293
Bermondsey	3,547	3,293	1,015	210	1,225	34·5	952	860[i]	256
Camberwell	6,149	5,368	19	0[e]	19	0·3	1,605	2,935	633
Deptford	2,956	3,014	0	325[f]	325	10·9	723	861	1,091
Greenwich	2,335	2,280	0	0[f]	0	0·0	1,054	1,226	0[g]
Lambeth	6,571	7,091	615	254	869	15·9	2,376	1,368	0[g]
Lewisham	3,317	3,338	0	0	0	0·0	2,572	766	0[g]
Southwark	5,239	5,145	1,260	1,034[f]	2,294	41·4	1,305	1,854	0[g]
Wandsworth	6,278	6,027	0	? *	0	0·0	1,300	1,780	2,947
Woolwich	2,823	2,815	0	185	185	6·5	435	1,407	400
	101,649	97,451†	—	—	19,597[k]	—	26,866	32,461	11,280
	And unallocated		97	44					

* *A few through the Clapham Maternity Hospital.*

† *This figure includes notified births occurring in institutions, which are not accounted for in the subsequent columns.*

(a) The medical students from the London Hospital attended 880 cases in Bethnal Green and Stepney, and the midwives 1,990 cases. Of these 992 are returned by the M.O.H. as being in Bethnal Green, and the others in Stepney.

(b) The figures under columns iii. and iv. for this borough have been obtained indirectly. All the agencies work in other boroughs whose figures have been subtracted from the total figures given by the institution, and the residue assigned to Islington.

(c) The medical students from St. Mary's Hospital work in Paddington and Kensington, but the department was temporarily closed at the outbreak of the war. The number of cases in 1913 was about 800, distributed fairly evenly between the two boroughs.

(d) A few births in this borough are attended by a midwife in the district on behalf of the City of London Lying-in Hospital.

(e) In these boroughs some births are also attended by midwives in the district on behalf of the York Road Hospital.

(f) A few births in these boroughs are attended by midwives acting on behalf of the Miller Hospital.

(g) In these boroughs the figures in this column are known to be doctors' cases and have been added to column (vii.).

(i) Includes 139 births attended in connection with the British Hospital, Woolwich.

(k) In this figure the 97 and 44 unallocated births are not counted. In considering the total of this column as compared with the figures on pp. 21 and 24, these must be allowed for.

for instance, the figures are respectively 40·5 per cent. and 11·2 per cent., due almost certainly in large part to the fact that Stepney abounds in charitable institutions for midwifery aid, whereas in Poplar this form of assistance is almost absent. The same feature is shown later with regard to the number of in-patient births in Section B.

If the figures in Columns VII. and IX. be taken together as representing the births attended by doctors, it appears that in 1915

38,146 births were attended in their own homes by doctors,
32,461 births were attended in their own homes by midwives,
and 19,738 births were attended in their own homes by medical students or midwives connected with institutions.

90,345.

In addition, between 9,000 and 10,000 births occurred in institutions where the mothers were received as in-patients, as is explained in Section B. The Registrar-General gives 1,592 as the number of in-patient births not belonging to the county of London, so that, allowing for this number, there would appear to be between 2,000 and 3,000 births concerning which the nature of the attendance at birth cannot be ascertained. It is probable that these represent doctors' cases occurring for the most part in well-to-do families.

For practical purposes, therefore, the numbers of births attended by the various agencies given in Table I. may be regarded as correct.

In view of the great amount of work undertaken by institutions in London, especially north of the river, it seemed advisable to consider separately the percentage of births attended by the various agencies north and south of the river.

This was done, and the following figures obtained for the year 1915, births occurring in institutions being omitted, as in Table I.:—

TABLE II.

	North of the River.	South of the River.	Whole of London.
Attended from Institutions	14,343	5,313	19,656
Percentage of total registered ...	24·5	12·3	19·3
Attended by doctors	18,700	19,446	38,146
Percentage of total registered ...	31·9	45·1	37·5
Attended by Midwives	14,209	18,252	32,661
Percentage of total registered ...	24·2	42·4	32·1
Total number registered	58,610	43,039	101,649
Total number notified	55,779	41,672	97,451

The great difference in the percentage of cases attended by doctors and midwives respectively in the part south of the river where the institutional provision is less, adds further evidence to the figures of Column VI., in connection with which it has already

been mentioned that the institutions appear to have arisen at least in part as a demand for training, and not in response to the demand for charitable aid.

Although the figures for 1914 have not been fully worked out, sufficient information has been obtained to show that fundamentally the figures are similar to those for 1915. Perhaps the greatest difference has occurred in the number of births attended by medical students, which has fallen markedly for 1915. This is shown in greater detail in Section C, p. 14.

SECTION B.

In-Patient Maternity Work in the Metropolitan Area.

There are several classes of institutions which provide aid for women in child-birth. Some are concerned solely with such assistance, while in others this work forms only one of the activities of the institution, and may be of relatively subsidiary importance.

Broadly, they fall into four main groups, although some members of each group overlap with those of other groups.

Group I. consists of twelve hospitals concerned with the training of medical students.

Group II. consists of eight hospitals concerned with the training of midwives.

Group III. includes workhouses and Poor Law infirmaries.

Group IV. includes all the lying-in homes, recently registered.

Several of the hospitals in the first group also train midwives, who are mainly, but not exclusively, the nurses in training in the hospital for general nursing work, and some of the hospitals in Group II. allow medical students to attend the practice in the hospital.

Group I.—All the hospitals in this group have in-patient as well as out-patient maternity work, the former being of a restricted nature in certain hospitals. They admit cases for in-patient care among those applying for aid in the out-patient department, and also occasionally admit emergency maternity cases arising in the practice of doctors or midwives in the neighbourhood.

Some have a special ward for maternity cases, while others admit the special cases to the gynaecological ward. Where there is a special maternity ward it is usual to admit a proportion of normal cases as well as those actually in need of in-patient treatment.

The special wards are of more recent origin, and in some instances are directly due to the requirements of the Universities of Oxford and Cambridge, the students from which spend a part of their time training in the London hospitals.

The number of maternity beds varies in the different hospitals, but reaches 20 in only one instance. In most cases the number is about ten. The total number of beds available in the hospitals of this group, apart from the beds made for emergencies in the

gynaecological ward, is between 65 and 70. The number of births occurring in these institutions is shown on page 11.

Group II.—The hospitals in this group were founded mainly for the provision of maternity beds for poor women. In the process of development they have commenced the training of pupil-midwives, and all except one (the hospital worked by the Jewish Sick-room Helps' Society, where out-patient work is not at present undertaken, but is contemplated) have out-patient departments working in connection with the hospital. The out-patient work is considered fully in Section C.

At the present time the training of midwives forms an essential part of the work of these hospitals. It provides an economical source of labour in the wards, and the students' fees help in the general upkeep of the hospital. It is not unlikely that many of these hospitals may be affected financially by the increased length of training now required from pupils entering for the examination of the Central Midwives' Board, since fewer pupils may apply for training.

The total number of beds available in the hospitals of this group is just over 300, and, allowing for the occasional use of extra beds or of the beds in the labour wards, the number would reach about 330.

The hospitals comprised in this group are unevenly distributed geographically in the county of London. On the north side of the river there are 14, of which Stepney contains three, Westminster three, and St. Marylebone two. South of the river there are six, of which four are situated in Lambeth. The hospitals serve the district adjoining the hospital, regardless of the borough boundaries, but the above distribution results in considerable overlapping in certain areas, while others have no maternity hospital in the neighbourhood.

Group III.—Any detailed consideration of the maternity work of Poor Law institutions is outside the scope of this Report. The number of births occurring each year in these institutions is, however, of considerable interest, and is given below and is also shown in Table II. These institutions provide primarily for the Poor Law Union at whose expense they are maintained, although this restriction is not absolute, individual cases being received of residents in other unions.

During 1915, and since then, owing to the exigencies of providing accommodation for military purposes, certain infirmaries have been entirely closed as Poor-Law institutions, and those cases which would normally have been received there have been drafted into other infirmaries. The number of applications for admission into Poor Law institutions in London for maternity aid show a downward tendency, which is most marked in 1915.

In 1912 the total number of births in Poor Law institutions in London was 2,618; in 1913, 1,953; in 1914, 1,981; and in 1915, 1,390.

Group IV.—The registered lying-in homes are, with a few exceptions, small institutions, in charge of experienced midwives. The exceptions arise in the large rescue homes, which provide accommodation for the confinement and subsequent residence (for varying periods) of unmarried mothers.

In all these homes the tendency is for the patients to remain longer than is usual in hospitals, and the number of births is relatively much smaller in proportion to the accommodation.

Moreover, a number of the smaller homes are rarely fully occupied. They are provided for those who can afford to pay a fee which will bring a profit to the midwife who works the home. The midwives are usually also in private practice as midwives, apart from the in-patient work. Three guineas a week or more is charged.

It is probable that most of the women confined in these homes are not residents in the Metropolitan area. It is not possible to obtain any precise figure in regard to the number of births which take place in the institutions in this group, but it is probable that it lies between 600 and 1,000.

These institutions will only be considered incidentally in the present Report.

On the Provision for In-Patient Treatment for Maternity Cases in the Metropolitan Area.

The figures for the in-patient births given in the annual reports of the various institutions concerned have been collected, and tabulated, but in some cases where the figure was not mentioned this has been kindly supplied for the purpose of this Report.*

The total number of confinements occurring in the institution in Groups I., II., and III. in 1915 was 9,089, and in 1914 was 9,578. From the figures given in the reports the number appears, in the main, to be constant from year to year.

The number of births occurring in each institution is shown below according to their groups:—

Institutions in group I.

Name of hospital.	No. of births in 1914.	No. of births in 1915.
St. Thomas' hospital	506 ...	581
Middlesex hospital	427 ...	397
St. Bartholomew's hospital ...	326 (approx.)	290
London hospital	267 ...	275
University College	206 ...	160
Guy's hospital	102 ...	101
St. George's hospital	20 ...	21
Westminster	13 ...	8
Kings College	? a few only	8
Also *two* hospitals not falling into any group—		
New Hospital for Women ...	44 ...	42
French hospital	50 ...	43
Total for group I.	1,961 ...	1,926

NOTE.—Charing Cross, St. Mary's and the Royal Free hospitals take only emergency cases, and their number is negligible for the present purpose.

* The figures for St. Thomas's Hospital have been obtained from the Medical Officer of Health for Lambeth, and are the number of cases of in-patient births notified to him under the Notification of Births Act.

To face p. 10.

TABLE III.—Table showing the distribution according to the boroughs of the in-patient births in hospitals and Poor Law Institutions.

Name of Hospital.	Name of Borough—North of the River. City of London.	Bethnal Green.	Chelsea.	Finsbury.	Fulham.	Hammersmith.	Hackney.	Hampstead.	Holborn.	Islington.	Kensington.	Paddington.	Poplar.	St. Marylebone.	St. Pancras.	Shoreditch.	Stepney.	Stoke Newington.	Westminster.	Name of Borough—South of the River. Battersea.	Bermondsey.	Camberwell.	Deptford.	Greenwich.	Lambeth.	Lewisham.	Southwark.	Wandsworth.	Woolwich.
Queen Charlotte's	1	2	44	—	75	78	10	59	20	42	183	229	1	297	206	2	7	4	86	15	1	11	6	2	15	3	7	21	1
City of London Lying-in	8	38	3	72	4	4	35	8	33	235	6	10	12	27	91	205	27	23	25	10	2	3	1	—	5	4	3	2	2
General Lying-in (York Road) ...	5	1	29	1	9	5	1	—	4	—	1	2	—	3	5	—	1	—	124	56	27	82	5	—	179	3	182	42	—
Clapham Maternity	4	—	12	—	10	11	—	1	1	2	1	2	3	5	4	—	2	—	53	66	11	50	3	—	189	5	50	60	4
St. Thomas's	—	—	5	1	2	2	—	2	—	3	—	—	—	1	1	1	—	—	47	64	8	16	3	—	276	3	105	27	1
East End Mothers' Home ...	—	16	—	1	—	2	6	5	1	3	—	1	104	2	3	7	392	1	3	1	6	6	1	1	1	2	1	—	—
London	1	94	—	1	1	—	12	—	—	—	—	—	9	2	—	7	120	—	—	—	—	1	—	—	1	—	1	—	—
St. Bartholomew's	17	2	1	162	1	3	8	—	10	35	—	—	—	1	8	20	2	—	—	—	—	4	—	1	—	—	3	—	—
Middlesex	1	1	3	2	9	2	1	5	38	13	4	5	10	132	129	—	1	—	39	—	—	2	—	—	—	—	1	3	—
British Hospital (Woolwich) ...	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	2	2	37	1	12	2	—	175
Mothers' Hospital	1	—	2	4	1	2	79	3	1	2	5	1	5	2	4	1	1	6	1	3	—	5	3	1	5	2	1	4	2
Jewish Society's Hospital ...	—	16	—	—	—	—	7	—	—	3	—	1	2	—	—	6	109	1	—	—	1	—	—	1	—	—	2	—	—
University College	—	—	—	—	—	—	—	—	—	5	—	—	—	—	155	—	—	—	—	—	—	—	—	—	—	—	—	—	—
King's College	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	1	—	1	Military Families Hospital 74				
St. George's			?12	In all 21 births distributed in Chelsea and Westminster															?9										
Westminster	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	—	—	—	—	—	—	—	—	—	—
Guy's Hospital							In all 101 births probably fairly evenly distributed between Bermondsey														?50	and	Southwark.........				?51	—	—
New Hospital for Women ...					42 in all, probably mainly in Islington...					?24 and the remainder in					?18	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Poor Law Institutions	—	30	63	22	77 (in 1914, now sent elsewhere)	36	66 (includes those from Stoke Newington)	(see St. Marylebone)	60	82	146	85	46	80 (includes Hampstead)	76	74	126	(see Hackney, only a few)	1	37	23	50	29	20	104	52	80	70	21
Total births as in-patients of inhabitants of the Borough.	38	201	175	267	189	145	225	84	168	449	346	336	193	552	700	323	788	35	396	252	132	233	53	64	776	86	487	229	280
Total registered births in 1915 ...	150	3,514	1,099	2,198	3,870	2,707	4,844	1,317	672	7,544	3,118	2,746	4,742	1,823	4,755	3,114	7,512	916	1,969	3,824	3,547	6,149	2,956	2,335	6,571	3,317	5,239	6,278	2,823
Percentage of in-patients to total births.	25·3	5·7	15·9	12·1	4·9	5·3	4·7	6·4	25·0	5·9	11·0	12·2	3·9	30·2	14·6	10·3	10·4	3·8	10·0	6·6	3·7	3·7	1·8	2·8	11·8	2·5	9·3	3·6	9·8

Institutions in group II.

Name of hospital.		No. of births in 1914.		No. of births in 1915.
Queen Charlotte's hospital	...	1,782	...	1,817
General Lying-in hospital (York Road)	...	819	...	811
City of London Lying-in	...	1,055	...	1,011
East End Mothers Home	...	579	...	582
Clapham Maternity hospital	...	633	...	649
Mothers' hospital ...	...	439	...	485
Jewish Society's hospital	...	147	...	220
British Lying-in hospital	...	182	...	198
Total for group II. ...	...	5,636	...	5,773
Figures for group III.				
Poor Law Institutions	...	1,981	...	1,390

Total for groups I., II. and III. ... 9,578 in 1914 ... 9,089 in 1915

In 1915, out of a total number of registered births of 101,649, 9,089 occurred in maternity institutions in London, excluding lying-in homes—that is, 1 in every 11 births, or about 9 per cent. of all births.

Allowance must be made for 1,592 births occurring in London, but being resident outside the metropolitan area, and transferred to their proper district by the Registrar-General. (See footnote on page 54 of the Registra-General's annual summary for 1915.)

On the Distribution of the In-Patient Births according to Place of Residence in the County of London.

It has been possible, through the notifications of births sent in to the medical officers of health, to ascertain the place of residence of the women who enter hospitals for in-patient care in their confinement, and to apportion them according to the borough in which they live. Only one hospital, the City of London Lying-in Hospital, publishes details of the place of residence of its patients, and full advantage has been taken of the information given in the annual reports of this hospital.

The distribution is shown in Table III. The figures do not include births of residents outside the county of London, so that the total figure does not correspond with that just given for all in-patient births. The total for Table III. is 8,402, which, if the 1,592 births of non-residents be added, amounts to 9,994, or is 905 in excess of the total number for all the hospitals given above. It may be inferred, therefore, that 905 represents the number of cases of non-residents confined in the London hospitals, leaving some 700 non-resident births for the lying-in homes. Owing, however, to lack of more precise information as to the births of Group IV., much stress should not be laid upon this figure.

The interest of the figures in Table III. lies in two main points:—

(1) The wide distribution of the cases in many of the hospitals, and

(2) The extreme variation in the percentage of in-patient births among the inhabitants of the different boroughs.

The distribution of cases is somewhat unexpected, and suggests a considerable amount of waste of effort connected with travelling. The position is most marked in the large maternity hospitals, although some of the hospitals with maternity wards show that cases are admitted from a wide area. The facts set out in the table appear to indicate that where beds are readily available the people use them, the use thus not being a satisfactory measure of the need for the beds.

It may be that the cases coming from more distant parts are mainly abnormal cases, but here no definite statement can be made. The maternity hospitals still have, in some degree, a system of maternity letters, which are in the hands of those who subscribe to the hospital, and these letters are frequently distributed without due regard to the real need of in-patient care.

The facts in Table III. are shown diagrammatically in the accompanying map.

No available figures will readily show the proportion of cases which require in-patient care for their confinement, but some indication may be obtained. It is likely that the figure will vary in different localities, but it is impossible to make any estimate of the degree to which such variation will occur.

In making the attempted estimate below no regard has been taken of the convenience of the mother, but the sole criterion has been whether the cases were in need of the care which can be given in a hospital but which is not possible in the home of the patient.

The case of a primaparous woman is considered by some to require in-patient care, and while no doubt this saves a great deal of time and trouble to the doctor or the midwife, the experience of out-patient midwifery does not justify any general provision for in-patient care in these cases. In the majority of cases it is possible to ascertain beforehand whether in-patient care should be provided, or whether the mother can be attended in her own home. There must, however, remain a proportion of cases where difficulty will arise suddenly, or where previous detection of the trouble has been impossible.

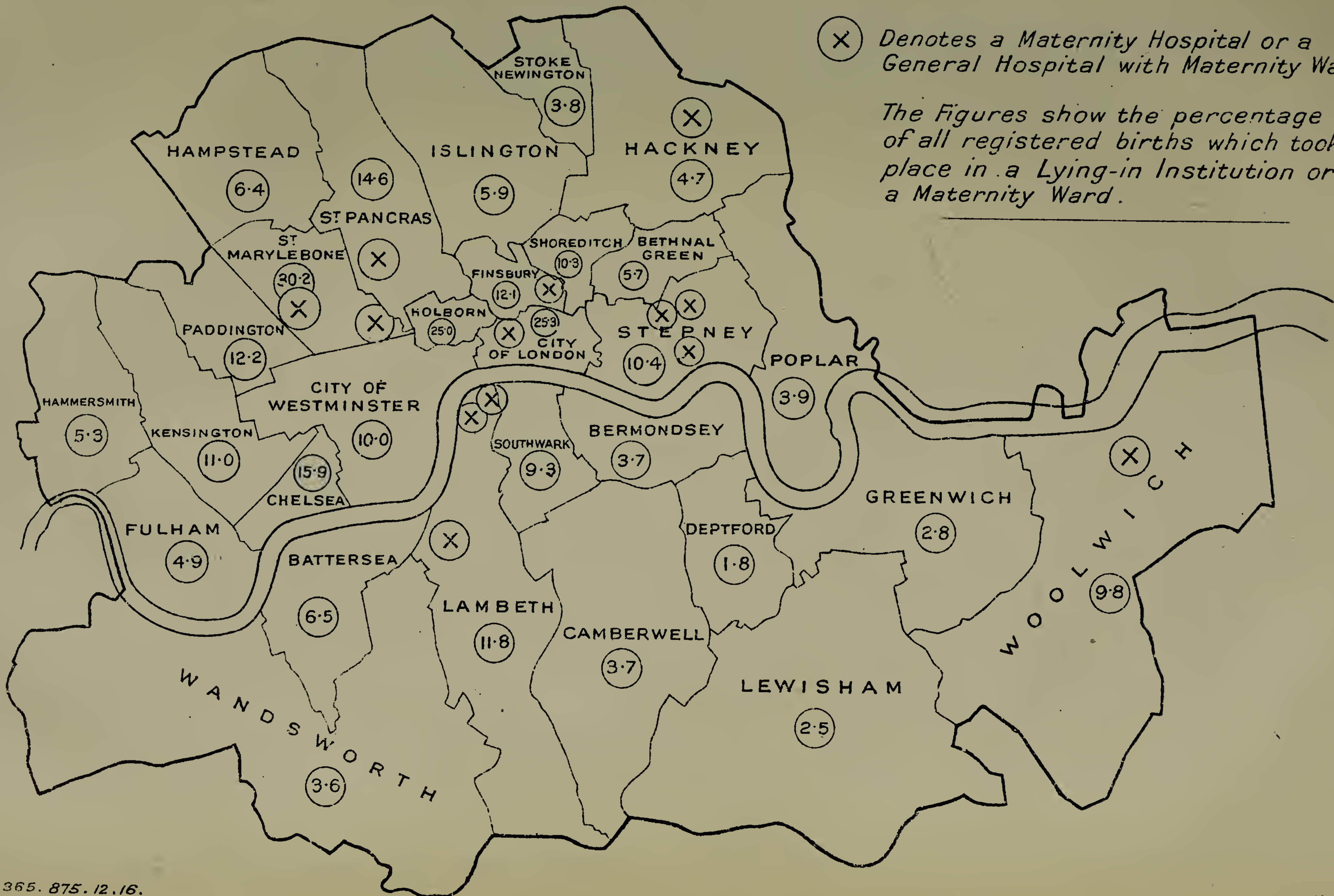
Many of the complications arising during labour can be, and are satisfactorily treated in the home of the patient, and do not require in-patient care.

The figures in Table III. do not afford much aid in ascertaining the proportion of cases needing in-patient care. The variation is too great to regard the figures as of value for this question.

In London, as has been shown on page 11, 9 per cent. of the confinements occur in hospitals, exclusive of lying-in homes. It may be surmised that medical needs do not demand a proportion exceeding 5 per cent.

Inquiry in connection with the number of cases in the practice of midwives which are referred by a midwife to a hospital as probably requiring in-patient care, suggests that from 2 to 3 per cent. of midwives' cases represents a probable figure. But it must

DIAGRAM MAP *showing percentage of in-patient births (after correction for home residence) among the inhabitants of each borough. The percentage is reckoned against the number of registered corrected births in each borough.*



Denotes a Maternity Hospital or a General Hospital with Maternity Ward.

The Figures show the percentage of all registered births which took place in a Lying-in Institution or a Maternity Ward.

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Malby & Sons, Lith.

be remembered that a woman who fears a difficult confinement will probably apply direct to a hospital, and not to a midwife.

The clinical reports of the hospitals show the number of abnormal cases which occurred in the in-patient practice of the hospital, but this practice is inevitably a selected practice, and almost certainly represents a much higher percentage of abnormal cases than really occur among an average population of women equal in number to those of the in-patients in the hospital.

It might be supposed that where a hospital has a large out-patient maternity department, with a ward for the admission of complicated cases only, that the figures of out-patients and in-patients respectively would supply the required information.

There is, however, a tendency for difficult cases to be sent direct to the hospital, and, moreover, some of the cases will certainly be emergency cases admitted from outside the hospital practice.

One hospital, in one of its clinical reports, states that out of over 2,000 women applying for out-patient care, 25, or 1·04 per cent., were advised that they would require in-patient treatment, and were admitted to the hospital for the confinement. It is likely that this figure is too low, as those not feeling well or anticipating difficulty would apply direct for in-patient care.

It seemed worth while to examine the clinical reports of the various maternity hospitals, in order to ascertain what might be regarded as a figure for those requiring in-patient care. The method of classification differs in different hospitals, so that the results are not absolutely comparable. Cases having merely an abnormal presentation without any suggestion in the clinical report of other complication have not been included, since in the majority of cases these could be treated in their homes. All cases stated to have been admitted on account of ante-natal trouble (hæmorrhage, albuminuria, or organic disease of any part of the body) for induction of labour, Cæsarian section, eclampsia, or for special manipulation, have been included.

Hospital A takes normal and abnormal cases. From 55-60 per cent. are primiparous women.

In 1910 the complicated cases admitted formed 9·0 per cent. of all cases.

In 1911 the complicated cases admitted formed 6·7 per cent. of all cases.

In 1912 the complicated cases admitted formed 7·0 per cent. of all cases.

In 1913 the complicated cases admitted formed 9·8 per cent. of cases.

In 1914 the complicated cases admitted formed 8·5 per cent. of all cases.

Hospital B takes normal and abnormal cases. From 38-42 per cent. are primiparous women.

In 1912 the complicated cases admitted formed 8·5 per cent. of all cases.

In 1913 the complicated cases admitted formed 11·0 per cent. of all cases.

In 1914 the complicated cases admitted formed 10·0 per cent. of all cases.

Hospital C takes normal and abnormal cases. In the year given 32·5 per cent. of all cases were primiparous women.

In 1912 the complicated cases admitted formed 7·6 per cent. of all cases.

Hospital D has a special ward for complicated cases connected with its own out-patient department, but also takes emergency cases. Taking the total admissions without clinical details (which are not available), and basing the percentage on the total out-patient cases, the figure for the in-patients is 11·3 per cent. in 1914 and 10·2 per cent. in 1915.

These figures include the emergency cases, and are probably too high. In another hospital, *E*, in two consecutive years 66 per cent. of all the cases were primiparous women, of whom 50 per cent. were unmarried. On the same basis as adopted above, the figure for those requiring in-patient care is 5 per cent. and 4 per cent. for the two years 1914 and 1915 respectively.

It is almost certain that the figures for hospitals *A* to *D* are too high for the general population as showing the prevalence of maternity complications. The aggregate figure for them all works out at almost exactly 9.0 per cent. In the absence of more accurate figures, if this estimate be applied to the whole population of London, approximately 9,000 cases might be regarded as needing in-patient care. It has been shown that this is the approximate figure, but it includes a preponderating number of normal cases, which might or might not require institutional treatment on other than medical grounds. The exact number of these cannot be ascertained, as clinical reports are only available from a few of the hospitals.

The main fault of the present Metropolitan arrangements in boroughs in which any shortage of facilities can be said to exist arises out of the unequal distribution, and not from lack of total accommodation for complicated cases.

SECTION C.

Out-Patient Maternity Work connected with Institutions.

The provision of aid in confinement for women in their own homes is carried out by 27 institutions in the county of London. Many of these institutions have other activities, and, in the case of the medical schools, the maternity work forms only a small part of the general work of the hospital.

For the purpose of this report any institution providing a midwifery service in the home and not being dependent for its maintenance upon the fees (if any) received from the women attended, is included in this section.

Many institutions, specially the medical schools, make no charge at all to the mother; others make a small charge, which is frequently reduced or remitted if the family circumstances are poor; while others ask for a fee which approximates to that of an independent midwife in the neighbourhood, but this fee may

be remitted or reduced. Although a few institutions obtain nearly the full fees asked, they are in no case sufficient to cover the cost to the institution, which must have other funds in order to carry on the work.

The cost of out-patient midwifery is higher in the case of institutions training pupil-midwives than where medical students are concerned, since the latter go out alone to the case while the pupil-midwives must be accompanied at all their cases by a trained midwife. The provision of the trained midwives is an expensive item in the work of training institutions for midwives.

As a whole, the institutions are charitable institutions, and the general intention is to provide a midwifery service for the poorer women only, referring those who can afford what may be considered an average midwifery fee to a private midwife. This, although simple in theory, is almost impossible in practice.

There is no fixed standard which can determine whether a woman can afford a reasonable fee or not. The institution has frequently no means of investigating the family circumstances, and even if this were so, opinions are not agreed as to what income, number of family, etc., taken together, can be regarded as enabling a woman to pay a reasonable midwifery fee

Moreover, although a number of these institutions were originally commenced purely as charities, they now, with very few exceptions, undertake the training of either medical students or pupil-midwives, sometimes of both. The funds which enable them to provide the midwifery service are, in part at least, derived from the fees paid for training, and a certain number of cases must be attended by those in training in order to obtain the qualification they are seeking.

All the medical schools and the large maternity hospitals, as well as some of the smaller institutions, provide free medical aid for emergencies which may arise in the out-patient practice. The medical aid is usually given by the medical officer resident in the hospital, or in some cases an arrangement is made with one or more local doctors. Others call in a local practitioner, when necessary, and provide the doctor's fee, but endeavour to recover some part of it, at any rate, from the mother.

The definite assurance that, should medical aid be required, no charge will be made is greatly appreciated by the women, as this may cause a heavy additional expense at a time when there are already extra calls upon the family income.

There are 12 medical schools in London, all of which have out-patient practices. (One has been temporarily closed during the war.) Of these, four also train pupil-midwives, the pupils being derived mainly, although not entirely, from among their own nurses in training.

The other training institutions take pupil-midwives only, although three of the maternity hospitals admit medical students or graduates in medicine to the in-patient practice. The out-patient work is, however, entirely in the hands of the pupil-midwives and those who instruct them.

The essential difference to the mother between the aid rendered her by the medical student and the midwife consists in

the fact that the midwife undertakes the nursing required for the ten days following the confinement, whereas the medical student, although paying visits during that period, does not undertake any actual nursing.

A certain amount of local sentiment undoubtedly attaches in some districts to the medical students from the well-known hospital to which all members of the family have been taken for many years, perhaps even for successive generations. Apart from this, however, the mother receives more assistance from a midwife connected with an institution which provides free medical aid, if required, than she does from a medical student.

Sub-section A.—The out-patient work of medical students.

Each medical student must be certified by the medical school he or she attends as having been through a course of practical midwifery work before receiving permission to sit for the final examination in medicine. The details of the course required differ somewhat in the different universities. Some universities demand in-patient as well as out-patient experience, while others make a stipulation in regard only to the total number of births which must be attended by each student. The usual number is a minimum of 20 births.

In-patient beds are expensive to maintain, while out-patient midwifery costs comparatively little. The total number of *in-patient births* in the hospitals which have medical schools attached has been shown on page 10 to be just below 2,000, and since in some hospitals the in-patient work is also used for training the pupil-midwives the number of cases available to the medical student is reduced.

The *out-patient births* attended by medical students in 1915 amounted approximately to 7,000, as shown on page 21, and this figure is much below that of the preceding year. There has been of recent years a gradual falling-off in the applications made at some of the hospitals for the attendance of the medical students at the confinement, so much so that in some practices the number of cases only suffices to meet the requirements of the universities.

It should be mentioned that St. Mary's Hospital had a large out-patient maternity department, which was closed at the outbreak of the war and will doubtless be reopened after the war. Some 800 births were attended in 1913 by the students from this hospital, being about equally divided between the boroughs of Paddington and Kensington. This hospital is, therefore, not reckoned in the figure for 1915, but appears in the figure for 1914 given on page 21.

In connection with the number of births attended by medical students a consideration of the total number of medical students who pass through the medical schools in London each year is of importance as showing the minimal number of cases which are needed in order to enable the students to qualify in medicine.

The figures given in the register prepared by the General Medical Council show that a considerable number of students commence their early medical studies at outlying colleges and

not at the medical school they will subsequently attend. Moreover, all students do not now register with the General Medical Council at the commencement of their training, and others who do register do not continue medical work. There is no way of ascertaining which of these students will finally attach themselves to medical schools in London and which to those in the provinces. In order, however, to obtain some estimate of the number passing through the London schools it has been assumed that in the majority of cases the student will attend the medical school nearest to the school or college at which he registered. Hence students registering at schools and colleges which are nearer to London than to any other university have been classed together and have been added to the number actually registering at the London medical schools. Moreover, since Oxford and Cambridge are closely associated with the medical schools of London, all the students registering at these universities, or at colleges known to supply these universities, have been added to those registering in London schools.

An analysis of the figures in the registers of the General Medical Council for the years 1912-15 inclusive gives the following figures:—

	1912.		1913.		1914.		1915.	
Total number registering in England and Wales	627		650		674		754	
Number registering in London, Oxford and Cambridge	337	386	327	365	305	365	296	356
Do. in colleges near the above...	49		38		60		60	
Do. registering at other universities	157	241	191	285	211	309	284	398
Do. in colleges near above	84		94		98		114	
		=627		=650		=674		=754

These figures show that while the total number of students registering has increased in each of these years, the increase has taken place in the number of those registering at universities outside London, Oxford and Cambridge.

It is interesting to note that if 20 be taken as the minimum number of births which a student must attend in order to qualify, about 7,000 cases (which is the approximate figure for out-patient cases attended by medical students in 1915), is the number required for the students registering.

In the aggregate, therefore, there is little margin of cases, although additional numbers are provided by the in-patient cases, and doubtless these students do not all take their midwifery work in London.

The out-patient maternity departments of medical schools have been regarded as of the nature of a charitable institution by the hospitals with which they were connected, and they have been the means of affording great assistance without charge to many thousands of poor women.

Originally the main feature was the attendance at the actual confinement, together with a few subsequent visits by either the student or the extern. The women were required to come up to the hospital some little while before the confinement was expected and apply for a "letter." This "letter" entitled them to attendance at the confinement, and was sent to the hospital when the woman was actually in labour.

It was not then the practice to make investigations into the case before the confinement, either with a view to ascertaining the family circumstances or the physical state of the woman. When a letter was received, the student next on the duty list went off to the case, not knowing at all what conditions he might find awaiting him.

The pitiful conditions of poverty and misery frequently seen by the medical students led to the formation of special funds for providing food and clothing for the lying-in women and for the babies. These funds were, for the most part, distributed under the auspices of the out-patient maternity department. Even now some hospitals give a considerable amount of material assistance to the cases they attend, on the recommendation of the extern of the department or of the students. Since there is no system of investigation, it is hardly surprising that persons working in connection with other relief agencies in the neighbourhood express the opinion that the material assistace thus given is not always bestowed upon the most needy or deserving.

Of recent years the whole outlook on midwifery work has altered, in conformity with the progress in social and general public health work.

The change, which amounts almost to a revolution in ideas, has been brought about by a number of influences. Among these must be reckoned the increase in knowledge of the means of avoiding septic conditions of the mother after the confinement, the improvements in hygiene and general cleanliness in the home, the passing of the Midwives Act, the growth of infant welfare work, together with the system of home visitation of infants, and many other matters whose exact degree of influence it is impossible to assess.

It is now recognised that it is not sufficient for the mother to be handed a "letter" for the charity by a porter or a clerk, but that she needs medical examination in order to discover any trouble, either local or general, which requires attention in order to secure the easiest possible labour and the healthiest possible child.

The condition of the home is increasingly recognised as a matter for investigation and assistance, either by advice or possibly by remedial measures through the sanitary staff of the district, as also the provision of clothing, etc., for the mother and for the expected infant.

The standard of care which should be given to the woman after the confinement and for the following days has also risen, and adequate maternity nursing is now recognised not as a luxury, but as a necessity.

Several of the medical schools have made important alterations in their out-patient maternity departments in conformity with

the general advance. Some have provided careful medical supervision of all women who apply for aid in their confinement, and take steps to deal with any unsatisfactory condition; while others, not able to secure medical supervision for all cases, have greatly increased their work in this direction.

Visiting in the home before the confinement has been arranged by several hospitals through the aid of the voluntary agencies for infant welfare working in their district, and in some cases through the medical officer of health of the borough in which the hospital works.

The almoners' departments, now forming a part of the organisation of nearly all the hospitals, do work of great value in connection with home visitation before the confinement, although this department cannot be regarded as covering all the matters which should be included in ante-natal visiting. At some hospitals the almoners investigate the social circumstances of those applying for maternity aid.

The question of providing maternity nursing has been faced and provided for by two of the medical schools. In one case the district is also worked by pupil-midwives who undertake the nursing for the cases attended by the medical students as well as those they themselves attend, and in the other case a special nurse with midwifery training is employed by the hospital for this purpose.

Several hospitals provide maternity nursing for special cases —where, for example, labour has been difficult—by arrangement with a district nursing association. One hospital also employs a trained nurse and midwife to assist the medical students at all confinements in the district, an arrangement of great value both for the mother and for the student. There is reason to believe that the instruction in practical midwifery given to medical students frequently lacks the thoroughness bestowed upon other branches of medicine, and the nature of the work presents difficulty in this direction, being irregular and liable to occur at all hours.

It has already been mentioned that medical students do not undertake maternity nursing. If any medical school provides this service for the cases attended by the student, some special arrangement must be made, as in the two cases quoted above. Where it is not provided the mother must herself make such arrangements as she can for her own needs.

Whether a student or a midwife is concerned some provision has to be made for the care of the home and family while the mother is laid aside. Usually a neighbour is engaged to perform this service. Where the mother has to make her own arrangements for maternity nursing she practically always contracts with this woman to attend to her as well as to the family.

These women are usually untrained in any form of nursing and are often dirty in their person and habits. Certain of them, however, are fairly cleanly and have acquired some knowledge as a result of experience and by seeing what is done by trained persons. They are under no inspection and cannot be called to account unless they perform some act which brings them within the sphere of the law.

Various names are applied to them—"handywoman," "waiting woman," "home help," "sick room help," etc.; but it appears that many of them like to be addressed as "nurse" and are not infrequently accorded this title.*

Latterly some hospitals have, through their almoners, been endeavouring to ascertain which of these women in the district can be regarded as satisfactory in their work, in order to advise the mothers whom they should engage to look after them in the lying-in period, but, as a whole, the hospitals do not concern themselves with the arrangements made by the mother for her own nursing.

At the first onset of labour the mother sends for this woman, who appears usually to decide when she will send for the doctor, the medical student, or the midwife, as the case may be.

Many of these women, apparently with the desire of feeling themselves important, refrain from sending to the hospital until too late, and the medical student arrives to find that the confinement is over, having been conducted or merely allowed to occur by the woman in charge. Such cases are commonly known as B.B.A.'s, or cases Born Before Arrival, and do not count in the total required for qualifying. It occasionally happens that the number of these cases becomes so considerable that the mothers have to be warned that if the baby is born before the student arrives the case will not be taken over. This may have a salutary effect for a time, but the difficulty is a common one in the out-patient work of medical students.

Sometimes trouble can be traced to one particular handywoman, who can be admonished, but some plausible excuse is usually ready, and there is no satisfactory remedy under existing circumstances.

The annoyance caused to the student is not perhaps the most unsatisfactory feature of the case. The consequences of the mismanagement on the part of the untrained woman must be borne by the hospital, apart from any detriment to the mother, unless the case be refused, which is not easy, as the excuse offered is often difficult to reject.

It must not be thought that the absence of full provision in accordance with modern requirements on the part of some of the medical schools is due to any lack of appreciation of the advantages of the increased services. This is far from being the case, and were money no object there is no doubt that full provision for all the items mentioned above would have been made.

The expense would be very heavy if the work were undertaken by any medical school with a large out-patient maternity department, and the cost would not be met even if a moderate fee were charged. Moreover, hospitals, which are institutions for free treatment, are usually averse from the introduction of fees for any of their services.

* The Jewish Sick Room Help Society has for some years, and certain infant welfare societies have more recently, provided women trained in household matters to look after the family and the home. These women are termed "home helps" and "sick room helps," but they are not expected to undertake any maternity nursing, and should only be employed in cases where a midwife or a maternity nurse has also been engaged.

There is a feeling at many hospitals that the service for attendance on uncomplicated midwifery cases (as are the majority of the out-patient cases) is undertaken solely because the hospital has a training school for medical students attached, and not because such work can be regarded as an essential part of the treatment of sick persons, which is the correct function of a hospital.

Hence there is a natural reluctance to employ hospital funds on any extensive scale for this purpose, even if such funds were available.

The problem of the adequate provision of ante- and post-natal care for the out-patient maternity cases presents a real difficulty to many hospitals with medical schools, the difficulty being greater in proportion to the size of the department.

A short summary of the work undertaken by the maternity out-patient department of each medical school is given in Appendix A.

The number of births attended in connection with the out-patient maternity departments of the different schools is annexed, and the total number of these occurring in each borough has been shown on Table I.

Table IV. shows the number of cases attended by the medical students of the twelve medical schools in London and their distribution in relation to the several boroughs:—

TABLE IV.

Name of School or Hospital to which attached.	No. in 1914.	No. in 1915.	Distribution as to Boroughs in 1915.
Guy's	2,236	1,815	1,015 in Bermondsey. 800 in Southwark.
London	1,732	880	All in BethnalGreen or Stepney.
University College	1,516	1,270	979 in St. Pancras. 291 in Finsbury and Islington of which probably about 200 were in Islington.
St. Bartholomew's	1,033	736	726 in Finsbury. 6 in Holborn. 4 in the City of London.
St. Thomas's	1,013	1,038	460 in Southwark. 578 in Lambeth (510 returned by M.O.H. as being notified.)
Royal Free Hospital	470	315	36 in Finsbury. 57 in St. Pancras. 58 in Holborn. 164 in Islington.
Middlesex	467	427	127 in St. Pancras. 114 in St. Marylebone. 89 in Westminster. 97 unallocated, but probably distributed among the above.
Charing Cross	224	205	86 in Holborn. 119 in Westminster.
St. George's	195	162	37 in Westminster. 117 in Chelsea. 8 in Kensington.
Westminster	189	157	All in Westminster.
King's College	120	56	37 in Lambeth. 19 in Camberwell.
Total	9,195	7,076	
St. Mary's in 1913	800		

The 97 unallocated births attended by students from Middlesex Hospital are probably to be located in the three boroughs given above, but a few may be in Holborn.

It has been impossible in all cases to distribute the births between two boroughs, and in some cases the figure has been arrived at by knowing the number of births in one or more of the boroughs in which the hospital district is situated and subtracting these from the total, thus getting the figure for the remaining borough.

Sub-section B.—Maternity work in the home by midwives connected with institutions.

It has already been mentioned that, with the exception of one or two, all the institutions falling within the category of this sub-section undertake the training of pupil-midwives.

The institutions can be most simply grouped under four headings:—

(i.) Those connected with general hospitals—four in number and attached to:—

The London Hospital.
Guy's Hospital.
University College Hospital.
Middlesex Hospital.

(ii.) That connected with a special hospital:—

The New Hospital for Women.

(iii.) Those connected with maternity hospitals, seven in number:—

Queen Charlotte's Hospital.
City of London Lying-in Hospital.
General Lying-in Hospital, York Road.
Clapham Maternity Hospital.
The East End Mothers' Home, Stepney.
The British Lying-in Hospital, Woolwich.
The Mothers' Hospital, Hackney.

(iv.) Institutions for out-patient maternity work only, seven in number:—

The Myddelton Square Maternity Association, in Finsbury, with branches in St. Pancras and Hackney.
The Nursing Sisters of St. John-the-Divine in Deptford and Poplar.
Mission of the Good Shepherd, Shoreditch.
Kensington Maternity Charity.
Ormond Home, Chelsea.
The Royal Maternity Charity.
The Miller Hospital, Greenwich.

Very few additional remarks are necessary on the general work of the above institutions other than those already made in this section. The outstanding feature of distinction between the work of medical students and pupil-midwives lies in the provision of maternity nursing by the latter as a part of their duty.

There is, however, no recognised standard of what should be

required in the matter of maternity nursing, and the various institutions take somewhat different views as to what should be included under this duty of the midwife.

A very high standard of what is required of a midwife is found in the work of many of these institutions, while in a few the standard must be regarded as somewhat low. As a whole the standard is good.

In regard to the matters which have been under consideration in the preceding sub-section the position here is very similar for the institutions for the first three groups.

Some have provided ante-natal medical supervision for all cases while others have increased the number of cases seen by the doctor.

The position as to the home visitation is much the same as for the general hospitals.

In the fourth group of institutions in this sub-section, however, conditions arise which differ from those met with at any of the institutions already considered.

The institutions in this group have no in-patient beds and there is no resident doctor in the institution. Some in this group provide free medical aid for emergencies, but in this case the nearest practitioner is usually called in and the fee paid, repayment being obtained, if possible, from the mother. Some, however, pay the fee and ask for no repayment whatever.

Among the institutions in this group it is usual, when a woman on coming to book shows evidence of probable difficulty at the confinement, or of the presence of some complication requiring medical aid, to refer her directly either to a doctor or to a hospital, since the midwife must advise medical advice in these cases.

If medical supervision of the mothers before the confinement is provided, this must be done by the definite appointment of a doctor to do this work, who attends at the institutions on a given day or days to see the women. One of the institutions in this group has already made this provision and another has arranged to refer their cases to the neighbouring ante-natal centre.

Doubtless much general useful advice is given by the matrons or heads of the institutions or by the sister-midwives when the women come to book, even where medical supervision is not provided, but the same might be said in the case of the out-patient departments of those hospitals where no ante-natal medical supervision is provided. This cannot, however, be regarded as replacing medical care.

Little or no material assistance is given by the out-patient departments of the maternity hospitals, or by the institutions in group iv., and in this last group the fees, except where they are remitted in whole or in part, are considerably higher than the out-patient charge made by all, except three, of the institutions of other groups, many of which make either no charge or only a low one, and even this is often remitted.

It might be assumed that the question of fees was entirely dependent upon the class of person who applied for attendance. But there is no clear evidence that this is the case, and the matrons of some of the institutions which ask for what are now considered

fairly good fees, do not think that more than a small percentage of their cases can be regarded as much better-to-do than many of the women who apply for aid to the hospitals.

It appears that at least in some degree, the comfort experienced by a mother when she is carefully looked after before, during, and after her confinement, is so much appreciated that she advises her friends to afford the required fee, and the practice of such institutions shows a marked tendency to rise. In fact, the fees charged by the institutions are in some cases rather higher than those charged by certain of the local midwives.

The question of fees charged by institutions in relation to the practice of local midwives will be considered in dealing with the work of the private midwives, on page .

It is impossible to investigate the number of cases which are required by the institutions for training midwives in order to provide for the qualifying number of cases, as was done in the case of medical students. Many pupil-midwives qualify entirely or mainly on in-patient cases, and many others are trained by private midwives whose cases are not included in the present section.

There is, however, reason to believe that the shortage lies rather in the number of pupils than in the number of cases available.

The number of cases attended as out-patients from the various institutions and the distribution in the boroughs is given in the accompanying table and the total number of such cases in each borough is shown in table I.

Short accounts of the work of the institutions in groups II., III., and IV. are given in Appendix B.

Table showing the number of cases attended in connection with the institutions providing out-patient maternity work by midwives—

Name of institution.	No. in 1915.	Distribution according to boroughs.
Group I. Connected with general hospitals.		
London Hospital... ...	1,990	In Bethnal Green and Stepney.
Guy's Hospital	1,111	901 in Southwark. 210 in Bermondsey.
University College Hospital	300	114 in St. Pancras. 186 probably all in St. Marylebone.
Middlesex Hospital ...	Cannot be separated from those attended by medical students. (*See* Table IV.)	
Group II. Connected with a special hospital.		
The New Hospital for Women	297	146 in St. Pancras. 6 in Finsbury. 145 in Islington.
Group III. Out-patient departments of maternity hospitals.		
Queen Charlotte's Hospital	2,223	700 in Kensington. 696 in St. Marylebone. 518 in Paddington. 30 in Hampstead. 279 probably all in Willesden.

Name of institution.	No. in 1915.	Distribution according to boroughs.
Group III. Out-patient departments of maternity hospitals—contd.		
East End Mothers' Home	1,166	All in Stepney.
York Road General Lying-in Hospital	357	133 in Southwark, 224 in Lambeth — in the "home" district. (513 through independent midwives in other parts.)
City of London Lying-in Hospital	639	432 in Shoreditch. 133 in Finsbury. 71 in Islington. 2 in City of London. 1 in Bethnal Green. (19 through an independent midwife in Hackney.)
Clapham Maternity Hospital	426	352 in Battersea. 30 in Lambeth, and 44 unallocated.
Mothers' Hospital, Clapton	1,331	800 approx. in Hackney. 350 in Shoreditch, and the rest in West Ham.
British Lying-in Hospital	324	185 in Woolwich. 139 in Rotherhithe.
Group IV. Institutions for out-patient work only.		
Myddelton Square Association	1,363	347 in St. Pancras. 168 in Finsbury. 272 in Hackney. 128 in Holborn. 448 probably all in Islington.
St. John-the-Divine ...	860	535 in Poplar. 325 in Deptford.
Mission of the Good Shepherd	377	All in Shoreditch.
Kensington Maternity Association	315	All in Kensington.
Ormond Home	197	85 in Westminster. 112 in Chelsea.
The Royal Maternity Charity		(Cases distributed to private midwives in various parts of London and surrounding districts, not counted in this section, but under midwives cases.)
Miller Hospital		(As for the Royal Maternity Charity. Cases in Greenwich, Deptford and Lewisham.)

The total number of births attended in connection with the above institutions is 13,276, apart from those attended by the midwives from Middlesex Hospital. Of these 460 are probably to be assigned to areas outside the confines of the county of London, thus reducing the number within this area to 12,816. In

addition to these, payment is made to private midwives by institutions in respect of from 1,400-1,500 cases per annum. These are not included in the present table since they are undertaken by private midwives and are notified by them as their cases.

SECTION D.

Midwifery Work in the Home by General Practitioners.

It has been shown in Section A that medical practitioners were engaged to attend some 38,000 births in 1915, or if the whole discrepancy between the registered and the notified births be added to the doctors' cases, the figure would reach about 40,000, or rather more. The figures for 1915 show only a slight decrease on those of the previous year, the total for 1914 taken on the same basis as for 1915 being about 42,000. Allowing for the reduction in the number of births, which was 8,303 lower in 1915 than in 1914, the proportion of births attended by doctors has shown no tendency to decrease.

There will be a small number of cases where a midwife has attended under a doctor as a maternity nurse, and where she may have signed the notification form. These cases will have been included in the midwives' cases. Their number is stated to be small.

Cases nursed by midwives or nurses, residing in the houses of well-to-do persons will be included as doctors' cases, since even if the nurse signed the notification form, her name not being on the list of practising midwives, the case would be included among "others," which have been added to the doctors cases.

Medical practitioners attend a large number of midwifery cases among the poor. The average number of births found to require visiting by health visitors, owing to their social circumstances, is about 80 per cent. of all births. It is sometimes higher, and rarely lower.* On this basis it may be inferred that some 20,000 births occurred in 1915 among persons who were comparatively well-to-do and who would presumably engage a doctor. Since the doctors attended 40,000 births, about half their midwifery practice must lie among persons whose standard of living falls below that of those usually classed as well-to-do.

Although midwifery may be regarded in theory as being carried out by all general practitioners, actually this is not the case. There are some doctors who like midwifery work and who have a fairly large midwifery practice, but others do not want a great deal of this class of work, and some have definitely abandoned it for one reason or another. As the practitioners have become busier owing to the panel practice there has been an increased tendency on the part of some doctors to discourage their midwifery practice, and they have raised their fees very appreciably.

* It should be noted that births and not population are concerned, and the birth-rate among the better classes is very low.

The fee charged by doctors varies considerably, but appears to average from 1–2 guineas for poorer persons. The lower limit is probably less usual, and $1\frac{1}{2}$–2 guineas will represent the greater number of the fees. It is stated to vary considerably with the doctor's estimate of what the patient can afford, and some people are said to pay less than one guinea. But it is likely that these are special cases of the nature of a charity and the low fees are named in view of the circumstances of the applicant.

It is impossible to ascertain what proportion of women who engage a doctor for their confinement anticipate any difficulty, but it is certain that a large proportion of the cases are quite straightforward. The fee paid covers the attendance at the confinement and a certain number of visits afterwards. In difficult cases the value of the fee is often given many times over in the services rendered by the doctor.

It is no part of the duty of a doctor to undertake any of the nursing required for either the mother or the child, and someone must be engaged to do this. Moreover the home and the family require attention during the lying-in period, and arrangements must be made for this beforehand. Where a doctor is engaged by a woman who habitually does all her own housework, it is usual to engage a woman to combine the duties of a maternity nurse and of a homekeeper.

These women have already been mentioned in connection with the work of medical students, where attention was drawn to the unsatisfactory nature of the service, and to their neglect to send in time for the medical student. It may be that the women who work under doctors are rather superior to those who work for women who are attended by medical students, since it may be assumed that on the whole the women will be rather better off, and able to afford to employ a better-class woman. But it does not seem that there is any marked difference between the nature of the attendance, at least in a great many instances.

After they have acquired some experience by working under doctors or midwives these women frequently entertain an entirely exaggerated idea of their own knowledge, and do not hesitate to say that they can quite well conduct a confinement without help. It is stated by midwives that some of them, after a time, refuse to work under midwives, as they regard themselves as quite as competent as a trained midwife.

The midwife, who must advise medical aid in the event of any difficulty, prefers to undertake the responsibility for the confinement herself, and does not hesitate to speak very firmly to the handywoman who has sent for her too late. As a result, it is said, that the midwife is sent for in time in nearly every instance. It is impossible to ascertain how frequently the handywoman conducts the confinement alone in a doctor's practice, but there is good reason to believe that they are a source of considerable trouble to doctors as well as to medical students and midwives. The benefit of the Midwives Act is reduced when these women act alone.

It is difficult to understand the attitude of the handywoman who defers the call for the doctor until too late. There seems

no reason, beyond the desire to be important, why she should wish to assume the responsibility of conducting or of attempting to conduct the labour, without any reward. They do not perhaps realise that much responsibility is involved, and hope that if anything unfortunate happens that the doctor will take the responsibility.

It is stated that in some cases the woman asks for more money because she has had to conduct the confinement, but extensive inquiry has not revealed any definite evidence that this can be regarded as a practice.

There are doubtless certain regrettable cases where a doctor has contracted with one of these women, not to send for him unless there is difficulty. In such cases it may be that the woman receives a part of the doctor's fee, the doctor taking any responsibility necessary for the woman's negligence or incompetence. This is "covering," and has been condemned by the General Medical Council. Doubtless some doctors have never appreciated the true position, but, finding that in the majority of cases no serious trouble has arisen, have, when particularly busy not made any great effort to arrive at the confinement in time. Now that the matter has received attention the doctors will no doubt take steps to prevent the occurrence of this unqualified midwifery practice.

It is, however, almost impossible for any doctor to be certain that he will be able to attend at any given confinement, and with the best intentions there will inevitably be a number of cases where the doctor is not present. The only remedy for this, in the view of the writer, is to ensure the engagement of a certificated midwife for all confinements, whether a doctor is also engaged or not; where the family income is small it would hardly be possible for this provision to be afforded by the woman herself.

SECTION E.

The Work of Independent Midwives in the Metropolitan Area.

A.—Statistical Notes.

The total number of midwives who notified their intention to practice within the County of London in 1915 was 495. Of these, 90 were connected with hospitals or other institutions providing midwifery service, and 28 were connected with Poor Law institutions.

Where the institution carries on both in-patient and out-patient work it is difficult to state the exact apportionment of the midwives in the two spheres of activity. It is probable that 40 of the total number (90) were engaged mainly, if not entirely, on out-patient work, and the remainder on in-patient work.

In addition to the above a considerable number of midwives sent in notifications of intention to practise, but these were only

temporarily in practice in London, and were taking cases either on account of sickness, absence or temporary increase in work on the part of other midwives in practice. These are not included, as they form no part of the total midwives in practice.

After deducting the 118 midwives connected with institutions the number actually in practice is found to be 377, of whom 329 are midwives by examination and 48 are registered in virtue of having been in practice before 1902. Of the 48, four are in practice with trained midwives, and their work cannot be separated from that of the latter. In reckoning the number of cases attended by midwives by examination the number attended by the four *bonâ fide* midwives are included.

In the aggregate 32,461 births were attended by the 377 midwives in 1915, who were in practice in the county of London, or an overage of 86·1 cases each. The 333 certificated midwives (this figure includes the four *bonâ fides* above mentioned) attended 29,063 cases or 87·3 each, and the 44 *bonâ fide* midwives attended 3,458 births, or 78·6 each. The total number of births attended by midwives for 1914 cannot be ascertained with the same exactness as for 1915, but in such districts as this has been possible, the figure is almost identical with that for 1915, although the tendency is to be slightly below that for 1914. That might be expected in view of the total reduction in births.

The average figures for the births attended by midwives do not indicate the actual number of births attended by more than a small proportion of midwives. About 30 of the trained midwives and two of the *bonâ fide* midwives attended no cases at all, while one trained midwife working alone attended 506, and one untrained midwife 375 births.

Where a midwife employs assistant midwives the actual number of births attended by each of the assistants is of no consequence and they are not allocated, although the number of assistants employed has been taken into account in estimating the average number of cases per midwife.

So far as can be ascertained there are some single-handed midwives whose practice exceeds, on the average, 200 births per annum,* and of these six are *bonâ fide* midwives. In addition there are several practices of over 200 births, where the midwife has one or more assistants or partners. The largest in 1914 was a practice of 689 births, where four midwives are employed by the midwife who owns the practice, and seven pupils are usually in training. A fair number of midwives have one pupil in training, which increases the number of cases they can undertake.

In view of the difference in the percentage of births attended by midwives north and south of the river it seemed of interest to ascertain the average numbers of births attended by midwives in these two areas.

* The only source of information as to the size of the midwives' practice is obtained from the notification forms sent in to the M.Os.H. of the districts. These are sorted by the L.C.C. and a list made of the number of births in the practice of each midwife. The L.C.C. does not obtain a return from the midwives themselves as to the number of cases they have attended, although they are entered in the register of each midwife.

North of the river 209 independent midwives notified their intention to practise; they attended 14,209 births, or 67·9 each.

South of the river 168 independent midwives notified their intention to practise and they attended 18,252 births, or 108·6 each.

The work of the *bonâ fide* midwives is unevenly distributed both in regard to numbers and locality. Of the 44 *bonâ fide* midwives working alone and independently

2	attended	no cases.			
8	,,	less than 10 cases each.			
16	,,	over 10 and under 50 cases each.			
7	,,	,, 50	,,	,, 100	,, ,,
5	,,	,, 100	,,	,, 150	,, ,,

and the remaining six midwives attended 247, 250, 260, 272, 288, and 375 cases respectively. This shows that out of the whole 3,458 births attended by *bonâ fide* midwives, 1,692, or nearly 50 per cent. of the work, was in the hands of six out of the 44 women.

The cases attended by the above 44 *bonâ fide* midwives occur mainly in certain areas:—

Eight midwives attended 644 cases in Bethnal Green (380), Stepney (167), Poplar (87), and Shoreditch (30).

Nine midwives attended 641 cases in Hammersmith (213), and Fulham (431).

Three attended 652 births in Camberwell.

Six attended 275 births in Wandsworth (263) and Battersea (12); and three of the six having the largest practices work in: (1) Bermondsey; (2) Greenwich, extending into Deptford; and (3) St. Pancras, extending into Hampstead.

B.—General Arrangements.

Some indication of the general arrangements of midwives have already been given in this Report, but a few additional points require mention.

A large number of midwives practise alone. If her practice is one of any size the midwife must not be absent from home for more than a short period without leaving her address, in case she is wanted. If she goes for a holiday—a rare event in the lives of most of them—or is ill, or for any reason unable to carry on her work she must arrange with a neighbouring midwife to take on her practice or engage another midwife temporarily.

This continual tie and the responsibility inherent in a midwifery practice is a great inducement to midwives to take an assistant or a partner, always understood that the practice is likely to be large enough to bear the additional expense.

If a midwife wishes to take a pupil she must apply to the Central Midwives Board for permission. Her practice is then carefully inspected by the inspector of midwives, who visits a number of cases which have been attended by the midwife, and endeavours to be present while the midwife is actually at work. Permission to take a pupil is not given unless the midwife's work reaches a good standard. A midwife may be allowed one or more

pupils, and a few who have large practices and employ several assistants are recognised as training schools for midwives.

As a whole, the midwives who take pupils feel that they must be even more particular than if they worked single-handed. The pupil does not relieve the midwife from any attendance at the confinement, but she assists in the maternity nursing, especially towards the end of the 10 days after birth. The work of the pupil must be carefully supervised, and during the early part of her training she is rather a hindrance than a help. In the long run, however, they undoubtedly assist the midwife considerably and enable her to undertake more work than she could do alone, if the work is to be well done. A precise estimate of the amount of help a pupil gives is difficult to make, but it seems probable that she may be regarded as relieving the midwife from about one-third of her work. This may be reduced or increased according to the quickness or intelligence of the pupil.

A small profit is usually made on the pupils' fees. The increased length of training now required for the Central Midwives Board examination will necessitate an increase in the fees asked by the midwives, as they clearly cannot afford to board their pupils for six months, for the same fee as for three months. For this reason there is some fear that the supply of pupil-midwives may be rather precarious.

C.—Fees.

The fees charged by midwives show considerable variation. It is usual to make a higher charge for attendance at first confinements, since more time has usually to be devoted to them. Midwives who charge 12s. 6d. for first cases usually charge 10s. for others, or if they charge 15s. for first babies then the ordinary charge would be 12s. 6d. A few midwives are now charging 15s. for ordinary cases and one guinea for first cases, in view of the existing prosperity due to the war. The variation in fees appears to depend rather upon the individual midwife than upon the locality in which she works. The fees charged do not necessarily correspond to the fees received.

A few midwives practise among persons whose financial circumstances are fairly good, and in these cases they may receive higher fees than those above mentioned, or again, if they act as maternity nurse under a doctor they may receive two guineas or more, but these higher fees are exceptional.

The average fee received is probably about 15s. among the midwives charging 15s. to one guinea, since fees are often reduced for one reason or another.

There are some midwives who have means of livelihood apart from their profession, but those who are dependent upon their profession must take a large number of cases and can only earn a living by working hard and continuously. The midwife may be out a part of five nights or more in the week, and will be working most of the day as well. A busy midwife will, apart from the attendance at the confinement, be out on her rounds from about 9.30 a.m., or earlier, until 2.0 p.m. or even much later without pause. After that she may have special visits to pay or

be engaged in booking cases for future work. She is likely also to be up during the following night.

After a time these women appear to be unable to contemplate existence under any other conditions, and they take cases often at any low fee offered by the mother, when if they were not so hurried and had time to talk the matter over, they might be able to make better terms and not be so overworked.

Some women coming to book with a midwife appear to endeavour to obtain a reduction of charge by quoting neighbouring midwives as being willing to take lower fees, and indicating that if the fee is not reduced they will engage the cheaper midwife. Where the midwife has the strength of mind to refuse the reduction she appears often to get her fee accepted. But this attitude cannot be expected from all midwives, where some hundreds are concerned, and where at the best but a scanty livelihood is earned.

Midwives who practise in the neighbourhood of a number of institutions are frequently in difficulty as regards fees. Here the woman who wants a reduced fee threatens to apply for free midwifery. In some districts, especially to the north of the river, the provision of free midwifery or midwifery at very low fees exceeds the real demand, and many women who would pay a midwife's fee if no institution were available, obtain a free or almost free service because the institutions must provide training material for their students or pupils. In addition to the competition from institutions there are some midwives who unfortunately cannot refrain from underselling their neighbours. They let it be known that they will attend cases at a lower fee, but they also probably render less service. Although they no doubt gain some cases, many women are sensible enough to realise that they do not get the best attention for the lowest fee, but the whole procedure tends to lower the general level of fees in the neighbourhood.

Bad debts are another item to be reckoned with by the midwife. These have admittedly been reduced since the introduction of the maternity benefit, and the midwives have also raised their fees since the money became available. But, whereas before, the midwife was paid in instalments before the confinement, she now usually receives her fee when the maternity benefit has been paid over. Many, probably the majority of mothers, pay their fee as soon as they receive the maternity benefit, but others delay or assert that they have not as yet received the money. Sometimes the midwife has to make repeated application for her fee and may receive two or three shillings on each application. This is a very unpleasant and undignified procedure for the midwife, and she often prefers to relinquish her fee. It is by no means the general experience that the poorer persons pay less readily. Midwives state that as a whole their bad debts are not among those who are not entitled to maternity benefit, but are frequently among those who are receiving double maternity benefit. The number of persons who do not receive any maternity benefit appears to be almost negligible, especially at the present time, as many women are insured even if their husbands are not.

As the midwife must sign the application form for the maternity benefit she is fully aware of the expected receipt of either the single or the double maternity benefit.

There are some persons who seem never to pay a midwife. These get known to the midwives who have been a little while in the district, and their application is refused. They usually betake themselves to any new midwife who may settle near, and who may in consequence incur a number of bad debts.

It is possible that the income of a few midwives working single-handed may reach £150 per annum, but this will be quite exceptional, and in the majority of cases, even of large practices, £100 is rarely exceeded. The average income of a midwife must of necessity be much below this since it has been shown that the average number of cases attended by a midwife in London in 1915 was 88 (87·3). Even supposing that the average fee was 15s. the income would amount only to £66, making no allowance for bad debts or for reduced fees.

Moreover, this income is a gross income and not a net income. The midwife must provide the necessary apparatus, cotton-wool, disinfectants, drugs, etc., which may be required, although a few midwives succeed in getting the patient to provide wool and disinfectant. Expenditure is also frequently incurred in connection with payment of doctor's fees, when medical aid is summoned to the confinement. The extent of this expenditure is dealt with on pages 36 37

Special Fees.—The question of fees cannot be left without reference to the arrangement made by certain charitable institutions with private midwives.

The charities are old-established ones, for the provision of free midwifery for poor women. The service is available through subscribers' letters, which are either distributed by the subscribers or sent to the institution for distribution. The letter entitles the holder to free midwifery service. The institutions providing the charity contract with independent midwives in different parts of London to undertake this service on their behalf: The fee offered to the midwife is 6s. a case, together with the provision of a small sum for drugs, or it may be of the drugs and disinfectants themselves. If medical aid is required the charity either sends its own doctor (as in the case of a hospital) or pays the fee of the doctor who is called in. One of these charities provides a midwife's bag for the use of the midwife in cases sent from the charity.

The holder of the letter must first apply at the central office, where she is given the name and address of the nearest midwife who works for the charity.

Little, if any, investigation is made into the circumstances of those receiving these letters entitling them to free midwifery, and there is no doubt that at least a fair proportion of them could afford to pay a midwife's fee.

The fee of 6s. is so small that if adequate service is rendered the charity appears to be mainly on the part of the midwife, and only secondarily on the part of the charity. It is somewhat curious that midwives can be found to undertake this work for the money, and several reasons are given as to why this is done.

The chief reason seems to be that the medical fee is guaranteed, and that they have neither to ask for it from the patient or provide it themselves. Some of the midwives need cases for their pupils and accept the work on that ground. One maternity hospital and one outlying general hospital practise this system of free midwifery and here some prestige attaches to the connection with the hospital, in consideration of which the midwives are willing to take a reduced fee. In other cases the midwives undertook the work many years ago, before the inspection of midwives had commenced, when maternity nursing was hardly practised by midwives, and when maternity benefit had scarcely been even contemplated. In such times 6s., together with the provision of medical aid and some disinfectants, was probably remunerative to the midwife. But times have changed, although the arrangements made by the charities have not, and now 6s. must be regarded as an inadequate fee.

If a midwife gives good maternity nursing for the cases sent her by the charity she does it out of personal charity and not because she is paid for it. If all the cases receiving the charity were really in need of charity the position would be rather different, but this appears frequently not to be the case. Some of the midwives honourably give full service for the small fee, especially where they have pupils, but in other cases there is evidence that additional payment is asked for from the mother if adequate service is rendered by the midwife. If a midwife finds that the person she is attending for 6s. could have afforded to pay her full fee, there is a very natural temptation to ask for payment rather than perform a charity. It may be mentioned that the two largest maternity hospitals formerly had this arrangement, but have now abandoned it on account of its unsatisfactory nature.

D.—Booking and Ante-natal Work.

The period of pregnancy at which women come to "book" with a midwife varies somewhat, but appears most frequently to be between the fourth and sixth month, sometimes rather earlier, or later.

At this visit the midwife makes inquiry as to the date of the expected confinement, the occurrence of previous labours, etc. Some midwives carry their inquiries a good deal further, and ascertain the presence of any symptom of ill-health, discuss the habits of life and feeding of the mother, and talk over the clothing which will be required by the mother for the confinement, and for the infant. A few examine the urine of all their patients at regular intervals, and measure the pelvis in the case of first babies or where there may be reason to suspect some difficulty.

A number of midwives have special hours when they are at home for any of their patients who may care to ask their advice or help on any matter, and some make a point of asking the mothers to come up at intervals before the confinement.

The mother inquires at the time of booking what the fee will be, and this appears to be fixed at this visit even when a reduced fee is to be taken.

Before the provision of the maternity benefit the women frequently brought up small sums each week in gradual payment of the fee. These visits gave good opportunity to the midwife to inquire into the mother's general health, progress of the arrangements for the confinement, etc. Now the midwife is usually paid after the attendance has been completed, and the mother has no reason which induces her to call regularly upon the midwife before the confinement.

Apart from such advice as may be given at the time of booking, any further ante-natal work must for the most part be due to a direct request on the part of the midwife that the woman will call upon her.

A few midwives, especially some of those who take pupils, devote considerable attention and trouble to ante-natal work. Many midwives are, however, very busy, almost hopelessly overworked, and have not the necessary time to devote to this purpose. Others say, quite honestly, that the fee they receive from their patients is already considerably too low for the services rendered, and that they do not feel able to do more for their patients than they already do. As a whole, the amount of ante-natal work done by midwives at the present time is not large, but many midwives would do more, and are competent to do it, if they had time and were paid for it. A large number of them fully appreciate the value of such work, both to the mother and child, and also to themselves, in relation to the provision for the confinement.

The revised Rules of the Central Midwives Board state in regard to ante-natal work: "When engaged to attend a labour the midwife must interview her patient at the earliest opportunity to inquire as to the course of the previous pregnancies, confinements, and puerperia, both as regards mother and child, and to advise as to personal and general arrangements for the confinement, and, with the consent of the patient, visit the house."

At the present time, visits to the home of the mother are only made before the onset of labour in very exceptional cases, but ante-natal work cannot be regarded as adequate unless home visitation is practised. It is essential that the condition of the home should be known, and, if necessary, improved, and that the midwife should actually see the provision which is being made for the confinement, quite apart from advice in regard to the health of the mother.

It is very desirable that opportunity should be afforded for the medical examination and, if need be, treatment of the mother during her pregnancy. Any midwife who suspects certain abnormal conditions in a patient who has engaged her to attend the confinement must, under her rules, advise medical care. Some doctors are very kind and take a great deal of trouble, especially where the case is referred to them by a midwife whom they know. The mother, however, has to pay a fee, and this often deters her from following the midwife's advice. Quite apart from the deterring effect of the payment of a fee, there are many women who refuse to go to a doctor unless they feel really ill.

There are now a fair number of centres where medical supervision of pregnant women is given free of charge, but these have not been utilised as much as might have been anticipated.

This should not be attributed to any opposition on the part of the midwives, nor to a lack of appreciation of the advantages offered. The difficulty is the same as with the ante-natal visiting. The midwife has not time to attend with her patient and fears to lose her by sending her alone to a centre when she may feel nervous or upset. Some nervousness is almost unavoidable in connection with any medical examination and is perhaps not always fully realised by those who work at a centre. The midwife should be able to take her patient up to the centre herself, both in order to hear the advice given and to reassure the mother, who may be rather nervous.

The object of these centres is to detect abnormal conditions and to give hygienic advice to the mother, together with treatment, if this is not otherwise provided for. Also to assist her in making provision for the confinement.

There is a fear on the part of many midwives that the centres are feeding grounds for hospitals and that the mothers will leave them and apply to a hospital for midwifery service if they attend the centre, especially if the centre is known to be connected with any hospital.

At present the midwives have not time to attend with their patients since this may involve two hours at least. Possibly it might be managed in certain cases if special appointments were made, and every consideration should be shown to the midwives for whose cases the benefits of the centre were primarily intended.

In any case there will be only a proportion of women who will be prepared to attend the centre even if the midwife herself goes with them, but efforts should be made to secure the attendance of as many as are willing to go. It is probable that 40 per cent. of all cases is the highest reasonable estimate.

Many women say that they have engaged the midwife because they did not want to go to a doctor, and if the midwife persists in sending them to the centre they may seek another midwife who will not trouble them on this matter.

Such cases have actually occurred in the practice of midwives who have advised and persuaded their patients to attend a centre alone.

Midwives are, however, agreed that if they could afford time to take their patients to the centre the difficulty would largely disappear.

E.—Attendance at the Confinement and the Provision of Medical Aid for Emergencies.

It is not necessary to comment upon the actual work of the midwives at the confinement, where medical aid is not required. The practice of the midwives is under inspection, and although different standards of work are inevitable, there is every reason to believe that the work is well done.

The midwife is obliged, under her rules, to advise medical aid in certain circumstances. It was shown in a previous Report

(Supplement to the Medical Officer of the Local Government Board's 44th Annual Report on Maternal Mortality, p. 81 et seq.), that although the figure for the cases in which medical aid was summoned showed considerable variation, 10 per cent. might be taken as being near the mean figure. Such investigations as have been made in London by the Midwives Institute give identical results.

The midwife's position in regard to the provision of medical aid is difficult, and may be said, without exaggeration, to be a source of perpetual worry and anxiety to many of them. It should be at once stated, that, as a whole the doctors are extremely good in attending cases when sent for by a midwife, especially if she is known to them.

It is essential that the position should be fully stated since the provision of medical aid forms perhaps the most real difficulty in connection with the work of midwives.

Quite apart from other matters it is naturally an unpleasant task for the midwife to be obliged to ask for further help, and especially so when she has to ask for more money to be paid.

Medical aid for midwives' cases is at present only provided by the Guardians, and the system does not appear to be much used in London.

Up to the present no metropolitan borough council pays midwifery fees under the Board's maternity and child welfare scheme.

Some midwives make special arrangements for the payment of the doctor's fee. One or two make an additional charge of 1s. per case and guarantee the doctor's fee if he is called in. One midwife will pay the doctor's fee, if one is needed, if the patient pays an extra 5s. Others, especially those who charge 15s. to one guinea, make a practice of paying the doctor's fee without asking for any contribution from the mother. Some always take care that the doctor's fee is paid over to him before he leaves the case and secure part repayment of the fee by the patient if they can.

Others, however, make no arrangement and leave it to the doctor to get his fee if he can.

The fees charged by the doctors vary considerably. The most usual fee for instrumental delivery seems to be one guinea, but some doctors charge less for midwives whom they know, if the patient is poor. The charge for other emergencies varies from five shillings to two guineas, according to the doctor, the family circumstances, and the difficulty of the case, also with the need or otherwise of an anæsthetic.

The fee for visits to the mother after the confinement, if difficulty occurs later on, is about 2s. 6d. or 3s. 6d., but sometimes special arrangements are made.

Careful inquiry was made to ascertain the existence of any real difficulty in obtaining medical aid, and although a few cases were heard of, these were for the most part special cases with exceptional circumstances and not due to any unwillingness on the part of the doctor to attend. There are some doctors who, on account of advancing age or increasing practice, are unwilling to take emergency midwifery work unless no one else can be

obtained. Again, there have been cases where all the doctors applied to have been out, and until some system is arranged such cases are inevitable. As a whole, however, in view of the precariousness of the fee and the frequent great fatigue involved there is very much less difficulty in obtaining medical aid than might have been anticipated. This fact is very much to the credit of the doctors.

There will always be some cases where the doctor is annoyed at being called out for a trivial matter, but those midwives who are good at their work, and know when a doctor is really needed, generally have no difficulty in obtaining the prompt service of any doctor who knows them.

There is no doubt that the whole question of medical aid is viewed with less anxiety by those midwives who pay the doctor's fee when he is called in, and doctors would be hardly human if they did not attend more cheerfully when they know that the fee will definitely be paid to them before they leave the patient's house, than if they have no security of obtaining any fee at all.

The doctor is, in fact, being sent for without any guarantee of a fee to assist a class of persons who are licensed by the State for a part only of what may be necessary in the work of their profession. All the midwives who pay either a whole or a part of the doctor's fee, stated that they were convinced that the doctor had no idea whatever that the fee was not paid by the patient, and that if they suspected it was paid by the midwife they would not accept it. As a whole, the relationship between the doctors and the midwives is very good.

A form of insurance for the payment of doctors' fees was once started by the Midwives' Institute, but it could not be carried on. The midwives who joined the scheme paid 1s. for every case they attended whether medical aid was required or not.

The experience of a similar scheme which is worked in Liverpool suggests that the sum of 1s. is not sufficient to provide an insurance scheme of this type. In Liverpool the midwives pay 1s. per case to their association and an additional 1s. if medical aid is required. Out of this fund the association pays five-sevenths of that part of the doctor's fee of one guinea, which cannot be recovered from the patient. The remaining two-sevenths of the deficit is paid by the Town Council. The scheme could not be financed on this basis without the part payment of the fees by the patient; the amount of payment is assessed by the Inspector of Midwives.

It would be impossible, in London, for each case to be investigated by the Inspector of Midwives, and the cost of any system of collection would almost certainly absorb a large part of the money.

The increased charge of 1s. made by some midwives cannot be regarded as covering the cost of the provision of medical aid. Further details are given in Section F.

F. Maternity Nursing.—There is no general standard of maternity nursing as practised by midwives, nor are those who may be regarded as competent judges agreed as to what should be considered to be the duty of a midwife in this respect. It is

probable that if considerations of time and money were eliminated opinions might become more uniform.

There are some institutions and some midwives whose sense of the need for adequate maternity nursing is so great, that they devote full attention to this important work at the expense of much personal effort, time, and often actual cost.

In many cases, however, the standard appears to conform to what can be carried out by the existing staff or by the individual midwife, without additional expenditure of money or undue personal effort. The divergence of opinion and practice is frequently entirely based on finance.

If the staff of an institution is overworked, money must be found for additional staff or the nursing work neglected. If a midwife is overworked, she must either refuse cases, take an assistant, or diminish the amount of nursing of her cases.

There is substantial agreement among those practising the highest standard of maternity nursing, both among practising midwives and those connected with institutions. The chief items of difference are in regard to what is practicable in view of the conditions of the individual home, and not in regard to what should be considered the duty of a midwife.

The two persons concerned are the mother and the baby. The midwife under her rules is responsible for the well-being of them both during the ten days following the confinement, although specific directions are not laid down for her.

The aim of maternity nursing for the mother is to prevent the supervention of any septic condition during the puerperium, and to secure such conditions of cleanliness and general comfort as shall conduce to her speedy recovery. Cleanliness is essential, and the use of disinfectants for the mother is required. The highest standard enjoins daily, or in some cases more frequent, antiseptic washing, with general cleansing of the mother's body. Some wash the mother all over two or three times during the ten days, and wash the upper part of the body and brush the hair daily for the first few days, after which the mother is usually well enough to perform this service for herself. Careful attention is also directed to the condition of the breasts. In order to ensure a satisfactory condition of cleanliness changes of clothing and of sheets are necessary, and the midwife should be responsible for the cleanliness and order of the bed if she does not actually make the bed at her daily visit.

The provision made by the mothers for these last matters are very generally stated to have shown marked improvement of recent years, partly, no doubt, owing to greater care on the part of the midwives since the Midwives Act came into operation, and also partly to the maternity benefit. It is stated that the complete absence of any sheets is now rare, and that some change of clothing is usually provided for both mother and child, while in a number of cases the provision is quite satisfactory.

Midwives who work in the poorest districts complain a good deal of the need for disinfection of the bedding, and even where the midwife would prefer to make the bed herself she may find the bedding too dirty and verminous to undertake it. The condition

of the bedding should be inquired into before the confinement in order that the local sanitary authority may, if necessary, disinfect it before the confinement. If the midwife visited in the home beforehand this could be attended to if tact were exercised.

Attention is required for the infant for similar reasons as for the mother. Umbilical sepsis is stated not to be a rare cause of death in the early days of life, although the figures cannot be given.

Minor troubles, however, arise from inattention to the umbilical cord, and the frequency of umbilical hernia among infants in this country suggests that proper attention may not be paid to the condition of the cord in the early days of life.

It is unnecessary to bring forward any figures as to the prevalence of umbilical hernia; anyone who has attended the practice of a children's out-patient department, or an infant welfare centre, must have been struck by the great number of these cases.

There can be no question that the care of the cord is one of the duties of a midwife, and should be attended to personally by her. Inasmuch as the washing of the baby is closely connected with the care of the cord, the former must be included as a duty of the midwife, at least until the cord has fallen off and the scar healed. A high standard of maternity nursing requires that the midwife shall wash the baby during the whole period during which she is responsible for its well-being.

The above considerations show that the duties of a midwife as maternity nurse make large demands upon her time, and to the busy midwife time is money. It is easy to see how maternity nursing may amount merely to a cursory antiseptic washing of the mother, a glance at the condition of the bed, a hasty sponging of the face and lower parts of the infant, and perhaps a rapid survey of the condition of the cord, the rest being either left entirely or relegated to the untrained handywoman.

It is evident that, owing to a call to another confinement, the midwife occasionally cannot devote full attention to her maternity nursing. This, however, is another matter, and is outside the considerations advanced above.

The amount of time required for the adequate maternity nursing of a case will depend a good deal upon the amount of preparation made for the midwife by the handywoman, in the way of hot water, etc., and also upon the period after the birth, since more attention is required in the early days.

Experts with great experience will not, for these reasons, specify any definite time for the performance of these duties, and a good deal also will depend upon the individual midwife. All are, however, agreed that in the early days the work cannot be properly done in less than three-quarters of an hour, and may take as long as $1\frac{1}{4}$ hours a day for several days.

The importance of maternity nursing is being increasingly realised both by experienced midwives and by the mothers, and there seems little doubt that many women are willing to pay rather higher fees to the midwife who is known to give good maternity nursing.

Where a midwife is paid a low fee there is a strong tendency to curtail the amount of care bestowed upon both mother and child.

SECTION F.

Economic Consideration of the Work of a Midwife.

A.—The cost of midwifery work connected with institutions.

The cost of in-patient work is shown each year in the reports of those hospitals which receive a grant from King Edward VII.'s Hospital Fund, and need not be considered here.

A statement of the cost of out-patient midwifery work would be useful and interesting if it could be ascertained with any degree of accuracy. Although extensive inquiry has been made it has been impossible to obtain figures which could be regarded as in any way reliable for the total cost per case. Where there is both in-patient and out-patient practice any accurate apportionment of the cost of the two services seems to be impracticable. The chief complication arises in connection with the pupils' fees and the cost of their board, etc., in relation to their services.

They work partly in the homes and partly in the wards, and the cost of the out-patient department, even where figures are published to show the cost per case, is found in each case not to allow for certain important items of expenditure, such as rent, etc., supposing that the apportionment of the pupil's time was correctly made. Where out-patient work only is undertaken, the midwives, on religious grounds, work either for no salary or only for so low a salary that the figures are valueless. In addition, the accounts of these institutions are complicated by other activities such as district nursing.

It was, therefore, necessary, to abandon the hope of ascertaining the cost of midwifery carried out in the home by institutions.

B.—Economic considerations connected with the work of private midwives.

Efforts were made to assess the monetary value of an adequate midwifery service by considering the actual incomes and expenditure of private midwives, and although much interesting and valuable information was obtained it was necessary to adopt a somewhat different method in order to reach the required figure. Many midwives keep no accounts at all and spend what they receive as it comes in. Others are not entirely dependent upon their work for their livelihood, and it was found that only those who were overworked or who took pupils make enough out of their practice to cover the cost of living.

Several who had been able to get along before the war were now found to be using some of their capital and were hoping that improvement might arise or that some means of livelihood would

present itself. These midwives were women of good type and stated to be carrying out very good work.

Their difficulty had been partly due to the rise in prices and partly to the provision of free midwifery for the wives of soldiers and sailors or by the growth of some neighbouring institution which undertakes out-patient midwifery.

Notes on the budgets of several midwives are as follows:—

Midwife A. Keeps accounts. Has had two boys to support, one of whom is now able to earn some money and the other is still at school. She works alone, and attended 243 cases in 1915. Her total income was £135. The outlay upon matters connected with her practice amounted almost exactly to £25 in 1915, or, approximately, 2s. a case. In addition, she was obliged to keep a maid to take messages which came for her while she was out, and this cost £26 per annum, allowing for the maid's food, etc. The upkeep of her bicycle cost an additional £2-3, which had not been included in the cost of the practice.

There remains an income of about £82 per annum for the midwife and her two boys. It need hardly be pointed out that very hard work is required to attend to 243 cases in the year. The work done by this midwife is stated to be of good type.

Midwife B. Keeps accounts roughly. Has an assistant to whom she pays £30 per annum, with all found. In 1915 they attended between 450-500 cases and earned £235 in all. She pays £53 in rent, rates and taxes, £20 approximately for drugs, washing of dresses, etc., and has to keep a girl to answer the door when she is out. In addition, she pays a good deal in doctor's fees, but did not know how much. The known figures reduce the income to £132 per annum, out of which board for three people, the maid's wages, heating, lighting, personal expenditure, etc., in addition to the unknown amount spent on doctors' fees must be provided.

She is out most nights in the week and works most of the day. A holiday is not even contemplated. She is stated to be a very good midwife.

Midwife C. Works with another midwife and has two pupils. Fees 10s. 6d. to 12s. 6d., but has a good many bad debts or reduced fees. The practice is of about 400-500 births in the year—447 in 1915. She keeps no exact accounts, but her gross income evidently cannot be much above £220 per annum. Out of this she pays rent, rates and taxes, in all about £50. The pupils' fees hardly cover their board, being eight guineas for six months. She must keep a maid, so that there are three people to feed apart from the pupils, together with lighting, heating, repairs,, clothing, etc. The doctors' fees paid by her are between £20-£30 per annum, sometimes more, and the expenditure on drugs "very heavy"—perhaps about £10 per annum. The cost of a holiday was quite prohibitive, and the partner had just taken a private maternity case in order to get a relative rest.

Midwife D. Widow; works alone, but in 1915 had the help of her daughter, who is a trained midwife. They attended 435 cases, and the total income was £155. She had a good many

bad debts and reduced fees. She works for one of the institutions which pays 6s. a case. She has been hardly hit by the free midwifery for soldiers' wives. It was impossible to do all that she would like to do for the cases she attended, but she could not afford to do more, and was already dipping into a small sum of money she possessed. The house is perhaps rather too large for her and she might reduce expenditure a little, but it has been her home all her married life, and she hesitates to break up the association.

Midwife E. Employs two trained midwives and has usually six pupils. In 1915 the staff attended 800 cases; of these 300 were institution cases at 6s., and 100 were attended free for a neighbouring midwife who was ill. The remainder paid fees of from 7s. 6d. to 15s. 6d. She had bad debts to the amount of £5 18s. 6d.; she pays the midwives one guinea a week each, or £109 4s. in all. Her doctors' bills for emergency cases were £24 6s. If an average of 10s. be allowed for the 400 cases in her private practice the total income was about £290 in all, out of which she paid £133 10s., without allowing for drugs or any household expenditure or of board for the midwives. The pupils' fees about cover their cost of board. There is a residue of £156 10s. for the rent of a house large enough to accommodate nine people, the heating, lighting, etc., and food for three people, without any allowance for personal expenditure, and holidays are out of the question. She does not know how she will carry on if food becomes more expensive or there is a reduction of fees after the war. She keeps no servant, as the pupils help in the housework and she does a good deal of cooking herself at odd times.

Midwife F. Widow, has a pupil, who is boarded by her married daughter, who occupies a part of the house. Keeps accounts. In 1915 she and her pupil attended 281 cases and received approximately £200 in fees. The pupil's fees cover her board only. The midwife works hard and well, her income just providing a livelihood and a holiday. Her budget for 1915 was as follows:—

	£	s.	d.
Household expenses (food, heating, etc.) ...	89	8	0
Holiday substitute and expenses of same	8	8	0
Paid to other midwives for help (she being unable to attend case)	4	0	0
Doctors' fees	9	2	6
Drugs and antiseptics	4	15	0
Apparatus		17	0
Insurance	1	9	7
Laundry (approximately)	6	10	0
Uniform, personal clothing, etc.	10	0	0
Holiday	10	0	0
Repairs to house, depreciation, etc.	10	0	0
Saved	35	0	0
Total	189	14	1

This midwife has a better class practice, and obtains 15s. to one guinea in fees. She has practically no bad debts.

Midwife G. Is employed by a doctor, together with another midwife. They live together, and attend 230 cases between them. They each receive £90 per annum and lodging, heating, lighting, etc., are provided. They pay their own laundry and food only.

They regard themselves as fully occupied with their cases together with some help in the surgery. They are very comfortable and are evidently well situated. The income and expenditure of the practice were not known, as there were no doctors' fees to be considered, because the doctor himself attended, and drugs were obtained from the surgery as required. These midwives are more favourably situated than any of those whose incomes are considered above.

The cost per case for drugs, etc., has risen greatly since the beginning of the war. Estimates made for previous years show that the cost was probably about 8d. to 10d. for each case, but at the present time, with the rise in price especially of disinfectants, the figure is between 1s. and 1s. 6d. per case, or even more, depending upon the nature of the case and upon the practice of the midwife.

Another method of inquiry into the monetary value of the services of the midwife proved more fruitful. Information was obtained from a large number of midwives, matrons, or heads of institutions carrying out midwifery work as to the number of cases a midwife might reasonably be called upon to undertake in the year, allowing for ante-natal work and for time to do the whole work properly.

The results obtained are remarkably concordant, although several different details of method were employed.

In some cases information was asked as to the total number of cases a midwife could attend in the year, in others the number which could be attended in the month, or again the number of cases which a midwife might reasonably be required to have on hand at any one time, allowance being made for some ante-natal visiting each day.

The number of cases which a midwife might reasonably be expected to attend in the whole year was universally given as 120, or perhaps 130 if the area of work was fairly compact, with a possible maximum of 150 if the midwife worked very hard.

In less populated districts the maximum should be about 100 or possibly 120, according to the district.

The number of cases which could be taken in the month of 30 days in a populated area was variously estimated at from 9 to 12, which brings the yearly total up to 108 or 144, the mean figure of which corresponds closely with that given for the year.

The number of visits a midwife is stated to be able to do properly in the morning, with allowance for some ante-natal visiting, and assuming that the actual confinements take place mainly in the afternoon or evening, is variously give at 3 or 4. Since a midwife attends for 10 days this means that she can undertake from 9 to 12 cases in a month of 30 days, an estimate which agrees with that obtained on the monthly basis.

In a few cases higher estimates were given for the daily or monthly estimates, but in these instances the midwives were themselves working from 9.30 a.m. till late in the afternoon, and were out most nights in the week. In this state of overwork they seemed unable to contemplate shorter hours, although they would be glad not to feel so pressed as at present. In other cases there was some reason to doubt the standard of maternity nursing which was expected.

The evidence shows, therefore, that the average number of births which a midwife could undertake with full service would be 120 in a town, or possibly 150 in an extreme case. In the country the figures would be 100 or less. Several experts gave 90 as an average, with an extreme figure of 120.

Further extensive inquiry was made in order to ascertain the cost of living to a midwife—that is, what sum she should be able to earn for the 120 cases in a town and for the 90-100 cases in the country. The figure of £2 per week was given with a uniformity amounting almost to monotony as being the sum necessary for the barest existence in a town. This figure makes no allowance for holiday, sickness, savings, personal clothing, or other personal expenditure. If allowance is made for these, the figure would need to be £3 per week, or £150 per annum.

It must be pointed out that a midwife incurs expenditure in virtue of her profession. She must have a private room in which she can interview her patients when they come to book. She must have some arrangement for dealing with calls for her services while she is out on visits, as the house cannot be left without someone there. If she is engaged most of the day and many nights she cannot attend to the house herself, and she must have someone to cook for her and generally help her in the house. A midwife is fortunate if she has a friend or relation who will live with her for the cost of her board alone; more usually she must employ a maid and pay her wages as well as provide for her board. Lodgings are not found to be satisfactory for a practising midwife.

The rules of the Central Midwives Board require the midwife to wear washing dresses, and her laundry bill is inevitably high.

In the country the expenses are less than in the town, since not only are rent, etc., lower, but food is cheaper, and neighbours will frequently take messages and render other neighbourly acts, in a manner that is not possible in a town, where many are strangers to one another. Those with experience state that £2 a week, or if possible rather over, would represent as good an income for a midwife in a small urban district as £3 per week for one in the town.

If £3 per week be regarded as a reasonable income for a midwife in a town, and 120 cases as the number she can attend in the year, the value of her services per case may be regarded as 25s., of which the ante-natal work, if this is undertaken, may be assessed roughly at 5s. For this sum, ante-natal visiting in the home and full midwifery attendance, with adequate maternity nursing, should be given. The expense incidental to the work of a midwife should also be provided out of this fee, but not the fee for the doctor, for which other arrangements are needed. A

midwife's fee of 25s. is beyond the capacity of all except a few of the patients they attend.

In the country or in small urban districts the number of cases which can be undertaken adequately in the year by a midwife will vary from 90-100. The services of a midwife must be regarded as of equal value to the community in whatever part of the country they are performed, and in the country the distances will be greater and more time will require to be devoted to each case. The fee paid should be the same as in the town—namely, 25s. Ninety cases at this fee would give an income of £112 10s., or just over £2 a week, which was stated to be the sum found by experience to be necessary for the support of a midwife in the country.

There is no doubt that if a midwife could feel reasonably certain of a livelihood based on the lines given above there would be no difficulty in ensuring a good midwifery service throughout the country. The work is attractive to many women, but the present arduous conditions tend to lower not only the number of women in practice, but also the type of woman who is willing to undertake the work.

SECTION G.
Notes on the Maternity Benefit.

The use or misuse of the maternity benefit has been so much discussed since the Insurance Act came into force that a special inquiry was made as to its effect, if any, in relation to midwifery work and the provision for the confinement.

The money was not, in the first instance, allocated to any specific item of expenditure in connection with the confinement. Whether or no the midwife's fee was intended to be a primary charge, there is no doubt at all that the midwife has had fewer bad debts, as a whole, since the introduction of the Insurance Act than before. Further, the fact that midwives have raised their fees since the maternity benefit became available indicates that they have felt an improvement in their position.

The fees for the doctor and midwife are, however, not the only expenditure which must be incurred in connection with the birth of a child. A woman must be engaged to look after the house and clothing must be provided for the mother and for the infant. The cost of these items has been inquired into, and the evidence collected is given below.

The Handywoman. This woman is usually engaged to attend to the house for a fortnight after the birth of the child. Her wages are extremely variable, and it was not possible to ascertain whether each woman has a fixed charge or a charge which varied with the social circumstances and requirements of the mother.

It is stated that among the very poorest women attended from institutions an exchange of service is sometimes made instead of payment. Midwives, however, expressed the opinion that, in their

experience it was rare for no payment to be made, even where the woman who came to help was a mother or a sister.

The charge made varies from 5s. to 15s. a week, and may include beer or beer money or food or both. The woman who receives 5s. does very little, and better value is probably obtained by paying rather more. As the fee rises more is expected both by the mother and by the woman. More service is usually rendered, but with the rise in fee comes the demand for food or beer, as above mentioned. Some will undertake the family washing, but others insist on this being sent out. When the fee reaches 12s. or more the woman often sleeps in the house.

A few midwives have lists of these women whom they recommend to their patients. During the war the fees have been raised somewhat all round, not only because of the general prosperity, but also because of the demand for women's labour.

Evidence obtained from the midwives is to the effect that the woman seldom costs the mother less than 10s. a week, including the value of her food or beer, and may very easily cost a good deal more. The cost of the food seems to be hardly thought of by the mothers, although it is clearly a charge upon the family income. Beer alone is stated to amount to from 3s. 6d. to 4s. 6d. a week at present prices. Further, if the washing is not done at home this is another item of expenditure. The woman is held to have first claim to payment, and it is stated that she is always paid. The cost is not less than 20s. to 24s. for the fortnight and may be more if the work done is in any way adequate. A measure of unconscious balancing appears to take place between the amount paid to the handywoman and the amount of maternity nursing known to be given by the midwife who has been engaged.

When the mother engages a good midwife there is some ground for believing that she engages a less expensive handywoman. Some midwives believe that this definitely occurs, and that an additional 2s. 6d. to a midwife, whose fees are rather higher, may save 3s. a week or more on the handywoman.

Provision for the confinement.—It has already been stated that of recent years there has been considerable improvement in the provision made for the confinement, part of which improvement at least may be regarded as due to the maternity benefit. Much further improvement is, however, needed. A large number of mothers are unable to sew sufficiently well to make the required garments themselves, although experience both of midwives and of infant welfare centres is conclusive as to the extraordinarily good results which can be obtained by the mere giving of advice and help for this purpose. At the present time the clothes are frequently either bought at a cheap ready-made shop, or are picked up second-hand on barrows or at pawnshops. It is said that better garments can be purchased second-hand for 3d. or 4d. than can be bought new for several times this money. Pawnbrokers sell bundles of baby clothing for a shilling or two according to the contents. Careful mothers buy these garments, wash and boil them before the confinement, and mend them if necessary. In other cases, however, midwives relate

that if the birth occurs somewhat before this was expected there is nothing for the baby until the pawnshop opens at 9.0 a.m. the next morning. This is not only unsatisfactory because of the risk to the baby, but because the clothes cannot be washed before being used.

The amount of money spent upon the clothing for the mother varies very much. In the poorer practices midwives stated that from 3s. to 5s. was about the sum spent, but others, in districts very nearly as poor, stated that they thought it was rare for less than 10s. to be spent, while others gave the figure at £1.

There can be no doubt that the lower figures represent an inadequate provision. The mother needs nightgowns, sheets, etc., but it may be supposed that in most cases some of these are already possessed. Estimates were obtained from various sources as to the cost of what might be considered to be an adequate provision for the infant. Much depends upon whether flannel or flannelette is used, and it need hardly be mentioned that flannel should be used, and not flannelette. One midwife stated that although 3s. was perhaps the most usual sum spent on clothes for the infant in her practice, this was quite insufficient, and she thought that if flannel were used it would be impossible to provide properly under £1 or more for a first baby. If a cot was bought it would cost at least 5s., and a perambulator about 24s.—in all, £2 9s. Other figures given for a cot and perambulator are 3s. and 22s. Further figures based on actual experience of the cost were 10s. to 12s. if flannelette were used, and from 12s. to 15s. at least, if flannel were used, and more if it was a first baby and everything had to be provided. These are minimum allowances in every way, both as to number of garments and amount of material used. No allowance is made here for cots or blankets for the baby, nor for a perambulator.

It is evident, therefore, that the cost of items connected with the confinement is heavy, and would more than absorb the maternity benefit.

There is abundant evidence to show that vast improvements in the clothing can be made by taking trouble, as would be done if the midwives carried out ante-natal visiting and helped the mothers to prepare for the confinement. It is more ignorance than lack of money which causes neglect to make the provision beforehand.

The present innovation of making ¾-length clothes for use for the infant until it can walk, makes the mother more ready to buy good material than if she has to provide long clothes which will be discarded at about two months old. The maternity benefit may be fully absorbed by the cost of the handywoman and the provision for the confinement, which at the lowest may be assessed at—handy-woman £1, clothing 10s., and, should it be a first baby there will be additional expenditure. The clothing, however, will rarely cost as little as 10s., and may reach £1 or more.

As to the use of the maternity benefit, it is certain that the actual coins or notes received in payment of the 30s. are often used for rent, boots for the other children, etc. The money has, in

fact, often been in part or in whole expended before it has been received, on matters connected with the confinement.

The coins which would ordinarily have been paid for the rent has been used to buy clothes at the pawnshop, or to pay the handy-woman, and when the maternity benefit is received the rent arrears are paid up.

There are no doubt unsatisfactory cases, and reference has already been made to the non-payment of midwives' fees by those having double maternity benefit, but, as a whole, the expenditure on a confinement is not covered by the 30s., and there is plenty of evidence that there has been a general improvement in the provision for the mother and child since the introduction of the maternity benefit.

A note on "Maternity Bags" would appear not to be out of place. These "bags" are supplied by a number of churches and societies, and contain clothing for the mother, generally sheets and nightgowns, and clothing for the baby. The mother has the loan of them after the baby is born for one month, when she is expected to return them in a cleanly state, and fit to be sent out again.

There are several objections to these "bags." They do not conduce to previous provision for the confinement, there is no certainty that the clothes will be returned again, and unless the whole bag is disinfected between each use there is risk of infection. Moreover, at the end of the month the baby is left without any clothes, since it is not likely that a mother who had neglected to make any preparations for the baby before it was born would make them in the early days after the birth.

Summary.

It has been shown in this Report that in the Metropolitan area, while there would appear to be sufficient in-patient accommodation for maternity cases, there is considerable inequality in its distribution.

Extensive midwifery attendance in the home is also provided by a number of hospitals and charitable institutions.

The information obtained in regard to the position of private midwives in the County of London shows that the economic position of those engaged in this profession is unsatisfactory, and that if adequate attenton is devoted to each case, it is hardly possible in existing circumstances for a reasonable livelihood to be earned.

APPENDIX A.

Notes on the Maternity Work of the Twelve Medical Schools of London, arranged in alphabetical order.

Charing Cross General Hospital, W.C.
(City of Westminster).

The maternity work carried out by this hospital forms but a small branch of the general activities.

In-patient treatment is provided only for emergency or for special cases, but there is an out-patient maternity department which is served by the medical students attending the hospital.

The district served lies in the Metropolitan Boroughs of Westminster and Holborn.

Numerous other institutions for the provision of midwifery work in this area, the chief being:—The medical students from Middlesex Hospital towards the north-west, and those from the Royal Free Hospital to the north-east, and those from Westminster Hospital towards the south, although these last work mainly further south. Pupil midwives work in Westminster from the Middlesex Hospital, and a number of cases in Holborn are attended by those from the Myddelton Square Maternity Charity.

The out-patient work.—Women coming to book are seen by a medical officer if this is considered necessary.

Home visitation is undertaken to some extent from the hospital, and all cases in Westminster are referred for visiting to the Westminster Health Society.

The hospital employs a midwife to assist the students at the confinement, and also provides maternity nursing for all cases. The number of cases attended in 1914 was 224 and in 1915, 205. *Fees charged,* nil.

Post-natal work.—An infant consultation is provided for the babies born under the hospital auspices. Home visitation is provided either by the hospital or by the Westminster Health Society by mutual arrangement.

Guy's Hospital, (Borough of Southwark).

The maternity work of this hospital forms a small part of its general activity.

In-patient care is provided for emergency or special cases only, but there is a large out-patient district served both by medical students and by pupil-midwives.

District served.—The west of the Borough of Bermondsey is served by medical students and a small part of the Borough of Southwark, the pupil-midwives working in Southwark only. During the war this division had been somewhat relaxed, and the pupil-midwives have taken cases outside their assigned area.

No other agencies work in Bermondsey, but St. Thomas's Hospital works in Southwark, although it is probable that there is little geographical overlapping. The midwives from York Road Hospital also work in Southwark.

In-patient work.—The total number of births in this hospital in 1914 were 102 and in 1915, 101.

Out-patient work.—All women coming to book are seen by the almoner, who is a trained nurse and midwife. If considered necessary they are referred to a member of the medical staff.

Efforts are being made to visit special cases before the confinement, but no definite arrangement exists at the present time.

Maternity nursing is available free of charge through an old charity in Bermondsey, if the mother applies for it after the baby is born. Comparatively few women avail themselves of this service, although the number seems to be increasing of recent years.

The number of cases attended by medical students and by the pupil-midwives was 2,236 and 1,079 in 1914, and 1,815 and 1,111 in 1915, respectively.

Fee charged.—No fee is taken, but if the women are too well-to-do they are refused assistance. Some who fall in between these two categories may, if they wish, give small donations to a special fund for providing material help to the poorest mothers, but it is made clear to them that their donation is for this purpose if they care to give it, and not for the hospital.

Post-natal work.—There is no special post-natal centre, but a very considerable amount of this work is carried on in connection with the children's out-patient department.

King's College Hospital, Denmark Hill, S.E.
(Borough of Lambeth).

The maternity work of this hospital has suffered as regards numbers by the recent removal from the Strand to Lambeth, and has been rendered additionally difficult owing to the absence of so many medical students at the war.

The hospital is at present largely given over to the military, and there are no in-patient maternity cases, although it was intended to use a ward for this purpose.

The out-patient department is worked by medical students.

District worked.—The district covers a large part of Camberwell and Lambeth.

The north portion is already worked by the students of St. Thomas's Hospital and by the pupil-midwives from York Road Hospital, and slightly also from the Clapham Maternity Charity.

Out-patient work.—All women who apply for the aid in confinement are seen at intervals throughout the period elapsing before the confinement, by the obstetric physician to the hospital, and are examined by him.

Some home visiting is done from the almoner's department, and certain cases are referred to a voluntary agency working in Camberwell.

Maternity nursing is not provided.

The number of cases attended in 1914 was 120 and in 1915, 56.

Fee charged.—No fee is charged, but those who can afford are expected to give a donation to the hospital.

Post-natal work.—A fair number of the babies are brought up to the children's out-patient department, although healthy.

The London Hospital (Borough of Stepney).

The maternity work of this hospital forms only a small part of its activities.

In-patient beds are provided for maternity patients, emergency cases being received into the gynæcological ward. There is also a large out-patient department served both by medical students and pupil-midwives.

The district served includes the greater part of both the boroughs of Stepney and Bethnal Green.

Other in-patient institutions in this area are the East End Mothers' Home, and the hospital of the Jewish Sick Room Helps Society, both in Stepney. There are no in-patient institutions in Bethnal Green.

No other medical students work in either borough, but the East End Mothers' Home has a large out-patient practice in Stepney, served by pupil-midwives.

In-patient work.—There are ten in-patient beds in the maternity ward, and the number of patients received in 1914 was 267, and in 1915, 275. Most of the cases are normal, abnormal ones entering as emergencies being admitted to the gynæcological ward. These last are not included in the figures just given.

Out-patient work.—The women on booking state whether they wish to be attended by a medical student or by a pupil-midwife.

They are seen by the out-patient maternity sister, by the maternity almoner, and by a doctor if this last is considered necessary by the sister.

Ante-natal visiting is carried out by the almoner's department, assisted in some cases by voluntary workers in the district.

Efforts are made to secure adequate provision for the confinement.

Maternity nursing is not provided for the medical students' cases.

The number of cases attended by medical students and pupil-midwives respectively in the years 1914 and 1915 were (1914) 1,732 and 1,656, and (1915) 880 and 1,990.

Fees charged.—No set fee is chargel, but each case is assessed by the maternity almoner and the women are informed what it is thought they should be able to pay. Many cases pay nothing, but others pay anything up to 15s. In assessing the amount regard is had to the cost of the handywoman, the required provision for clothing, etc.

Post-natal work is not undertaken, but the mothers are advised to take their baby to the nearest infant welfare centre. The district midwives keep in touch with many of the mothers and children for a considerable time, especially if the child was a premature infant.

The Middlesex Hospital, Mortimer Street, W.
(Borough of St. Marylebone).

Maternity work forms one part only of the activity of this hospital.

Both in-patient and out-patient care is provided, and the work

is carried out by medical students and pupil-midwives, under the supervision of the medical officer to the department.

The district served.—The hospital, although in St. Marylebone, is close to the boroughs of Holborn, St. Pancras and Westminster, and works in all of them, within a mile radius from the hospital. Other medical students working in this area are those from Charing Cross Hospital, in Westminster, and students from other medical schools in Holborn.

Pupil-midwives from University College Hospital work in St. Pancras, and from Queen Charlotte's Hospital in St. Marylebone.

In-patient work.—Ten maternity beds are provided for either normal or abnormal cases, the former being admitted only if there is room. The ward is always fully occupied.

In 1914 there were 427 in-patient cases, and in 1915, 397.

Out-patient work.—All women on booking are seen by the obstetrical assistant, being sent on to the almoner if there is some doubt as to the suitability of the case.

Ante-natal visiting of the Westminster cases is undertaken by the Westminster Health Society, and some visiting is done in the other boroughs. Visiting of special cases is sometimes done by the district sister attached to the maternity department.

Maternity nursing is provided for all cases, those attended in the confinement by medical students being nursed by the pupil-midwives. No distinction is made beforehand as to whether the case shall be attended by a student or a midwife, each take their turn when a case comes up.

The number of out-patient cases in 1914 was 467, and in 1915, 427.

Fees charged.—No fee is charged, but the women on their own initiative often contribute small sums to the hospital.

Post-natal work.—This is not undertaken, but there are infant welfare centres within reach of practically all the cases.

Royal Free Hospital, Gray's Inn Road, W.C. (*Borough of St. Pancras.*)

The maternity work carried out in connection with this hospital consists of out-patient work by the women medical students. A few special or emergency cases receive in-patient care. Considerable in-patient accommodation had been provided for maternity cases and was completed soon after the outbreak of the war. The premises have been used from the first for military beds. They will be used for the original purpose after the war.

District served.—The western part of Finsbury and Holborn, the southern portion of Islington, and a small area in the east of St. Pancras.

The borough of Finsbury is also served by medical students from St. Bartholomew's Hospital, and by pupil-midwives from the City of London Lying-in Hospital, and from the Myddelton Square Maternity Charity.

Holborn is also served by the medical students from Charing Cross Hospital, and slightly also by those from the Middlesex Hospital and from St. Bartholomew's.

St. Pancras and Islington are both served by medical students from University College Hospital and by pupil-midwives connected with the Myddelton Square Charity.

Out-patient work.—All cases applying for maternity aid are examined by the medical officer appointed for this work, and advice and treatment are provided.

Ante-natal visiting is carried out by a part-time trained visitor appointed for this purpose.

Maternity nursing is provided for cases having had difficult or complicated labour. The number of cases attended in 1914 was 470 and in 1915, 315.

Fees charged.—Nil. Material aid is provided in necessitous cases.

Post-natal work.—An infant consultation is held for the babies born in the hospital district.

St. Bartholomew's Hospital, E.C. (*City of London*).

Maternity work forms only a small portion of the activity of this hospital.

In-patient beds are provided and there is also a large out-patient maternity department worked by medical students.

District served.—Nearly the whole of Finsbury, the east portion of Holborn, and the City of London as far east as the level of London Bridge. Practically, however, the work is almost entirely confined to Finsbury.

Parts of Finsbury and Holborn are also served by medical students from the Royal Free Hospital, and the whole area is served by pupil-midwives, those from the City of London Lying-in Hospital in the eastern, and from Myddelton Square Charity in the western, portion.

In-patient work.—Pupil-midwives are trained in the wards as well as the medical students, and are women who have completed their training as nurses. About 16 beds are available for maternity cases, both normal and abnormal being taken, the latter being given preference.

The number of women confined as in-patients in 1915, was 290.

Out-patient work.—The women applying for maternity assistance are seen by the obstetric assistant, and, if necessary, are referred for further examination to one of the physicians. The cases are not seen by an almoner, and a good deal of material assistance is provided from a special fund. An ante-natal clinic is held weekly, and all women applying for maternity aid are kept under close observation up to the confinement.

No ante-natal visiting has so far been arranged for. Maternity nursing is provided for cases having had a difficult labour or for any special reason out of a fund for this purpose, by arrangement with the district nursing association.

The number of cases attended in the district in 1914 was 1,033, and in 1915, 736.

Post-natal work.—All delicate infants, when discharged from the Maternity Department, are transferred to that for the Diseases of Children. Mothers who have had any complications connected with their confinement are referred to the gynæcological out-patient department.

St. George's Hospital, S.W. (*City of Westminster*).

The maternity work is a small branch only of the work of this hospital.

In-patient care is provided in the gynæcological ward for such cases as require it, and there is an out-patient practice served by medical students.

District served.—The western part of the City of Westminster, the borough of Chelsea, and the eastern parts of Kensington.

No other medical students work in Chelsea or Kensington, but those from the Westminster Hospital work in the City of Westminster.

The area in Chelsea is also served by pupil-midwives from Ormond Home, King's Road, and by the York Road Hospital indirectly, through the affiliated midwives.

Out-patient work.—All women applying are seen by the assistant obstetric physician and the resident obstetrics assistant, who see them repeatedly before the confinement.

Many cases, but not all, are referred to the almoner. Cases requiring in-patient care are watched and a bed is reserved for them if necessary.

Ante-natal visiting is carried out in Westminster by the Westminster Health Society and in Chelsea by the Chelsea Health Society.

Maternity nursing is not provided.

The number of cases attended each year is about 200, the actual figures for 1914 and 1915 being 195 and 162 respectively.

Fee charged.—None.

Post-natal work.—Some infant care work is carried out.

St. Mary's Hospital (*Borough of Paddington*).

This general hospital formerly had a large out-patient maternity practice in Paddington and Kensington, but it was closed at the outbreak of the war, and will probably not be re-opened until the close of the war.

St. Thomas's Hospital (*Borough of Lambeth*).

This hospital is one of the large general hospitals and medical schools, the maternity work forming only one of its activities.

In-patient beds for confinements are provided, and there is a large out-patient maternity district served by the medical students.

The district served lies mainly to the south of the river, in the boroughs of Lambeth and Southwark, but a few cases come from the adjacent areas north or the river.

Other in-patient institutions for maternity cases in this area are the General lying-in Hospital in York Road, and the Clapham Maternity Hospital, in Jeffreys Road.

No other medical students carry on maternity out-patient work in this area, although those from King's College Hospital may eventually do so. So far, overlapping cannot be regarded as occurring.

Out-patient midwifery by midwives is carried on in this area by the midwives from York Road Hospital, from the Clapham Maternity Hospital, and in the Southwark district from Guy's Hospital.

In-patient work.—A number of maternity beds are provided, and the number of births which occurred in 1914 was 506, and in 1915, 683.

Both normal and abnormal cases are received, the former being taken only if there is room. All cases applying are investigated by the almoner's department. In 1915 the almoner, Miss Cummins, stated, in her annual report, that "Applications for admission to Mary Ward (the maternity ward) have been made by a very large number of patients on the ground that the rising cost of food is making it increasingly difficult to manage on a fixed income."

Out-patient maternity work.—All cases applying for maternity receive medical care, and any case requiring in-patient treatment at the confinement is at once entered as a future in-patient.

All are visited in their homes as a matter of routine through the almoner's department. Some of the visiting is done by the staff of the department, but the major part of the work is done by voluntary agencies in the neighbourhood, according to the district in which the mother lives, great care being taken to prevent overlapping of relief.

Maternity nursing is provided for any case where there has been a difficult labour, or where other unforeseen trouble has arisen. The nursing is done by arrangement with a nursing association.

The number of cases attended by the medical students is about 1,000, but shows signs of a slight decrease. In 1913 it was 1,037, in 1914 1,013, and in 1915, 969.

Fee charged.—No fee is charged, but the mothers may, if they wish, contribute to the hospital, as is the case with all patients. Material assistance is provided from the Samaritan Fund when this is found to be necessary.

Post-natal work.—Two infant clinics are held weekly for babies born under the hospital auspices, but any coming from areas in which reliable clinics exist are referred thither, the hospital receiving periodical reports for statistical purposes.

University College Hospital, Gower Street, W.C. *(Borough of St. Pancras.)*

This is a general hospital with medical school attached. The maternity work, although only one of its activities, forms a larger part of the whole work than is usual in a general teaching hospital of the size of University College Hospital.

There is an in-patient ward, and a large out-patient practice, served both by medical students and pupil-midwives.

District served.—With few exceptions the women aided live in either St. Pancras or Islington. All the southern part of both boroughs are in the hospital district, in-patients and out-patients being drawn approximately from the same area.

The medical students carry on the out-patient work in the area north of the Euston Road and Pentonville Road, as far north as Chalk Farm and Camden Town and east to the "Angel," while the pupil-midwives work in the southern part of the borough of St. Pancras—that is south of the Euston Road.

The area in Islington is also served by medical students from the Royal Free Hospital, and nearly the whole of the district worked by the medical students is covered by pupil-midwives from the Myddelton Square Charity.

The area south of the Euston Road is also served by medical students and midwives from the Middlesex Hospital.

In-patient work.—Eight maternity beds are provided and are reserved for cases where some abnormality is detected or where difficulty in labour may be anticipated. The number of in-patient births in 1914 was 206, and in 1915, 160.

Out-patient work.—All women applying for maternity assistance are seen by the extern obstetric assistant, who does the booking and makes enquiry into their circumstances.

Cases apparently too well off are not booked, but very few are said to be in this position. All primiparous women, or those having history of difficulty in previous labours, are seen by the obstetric registrar, in addition to the extern assistant. A large number of these women are seen on several occasions by the Registrar, who treats all the minor ailments.

Home visiting of any special case is done from the hospital, other cases in St. Pancras being referred to the Medical Officer of Health of St. Pancras, who distributes them to the agencies working in the appropriate part of the borough.

Maternity nursing is provided for special cases or for those where the labour has been difficult, this work being done by two nurses, who also visit the above-mentioned special cases before the confinement. The number of cases attended by the medical students varies from 1.200 to 1,400, and those attended by the pupil-midwives from 250 to 350. In 1915 the numbers were 1,270 and 300 respectively.

Fees charged.—None. Although each case is investigated it is only in isolated cases that there is one which is considered well enough off to be able to contribute even for in-patient attention.

Nearly all of them are in receipt of the maternity benefit, but this is regarded as required for other provision for the confinement.

Post-natal work.—An infant consultation is provided for the babies born in the hospital district, but owing to the size of the district many of them live nearer to other post-natal centres than to the hospital.

Westminster Hospital (City of Westminster).

The maternity work of this hospital forms only a small part of its activity.

In-patient treatment is provided for emergency or special cases only, but there is an out-patient department worked by the medical students attached to the hospital.

District served.—The south part of the borough of Westminster approximately from Charing Cross southwards, and a few cases are sometimes attended in Chelsea.

St. Thomas's Hospital students attend a few cases in this district, and also some are attended by independent midwives working for the York Road Hospital.

Out-patient work.—This is carried out by medical students. Special cases receive medical supervision before the confinement.

No maternity nursing is provided, but all cases are visited both ante-natally and post-natally by the Westminster Health Society.

The number of out-patients attended in 1914 was 189, and in 1915, 157.

Fees charged.—None.

Post-natal work.—No work is undertaken by the hospital, but the district in which the hospital works is served by the Westminster Health Society, working under the Westminster City Council.

APPENDIX B.

Notes on Institutions other than the above which provide a midwifery service, whether for in-patient or out-patient work, arranged in alphabetical order of—

(A) In-patient, either alone or with out-patient work.

(B) Out-patient work only.

(A) Institutions undertaking in-patient work, either alone or with out-patient work.

Maternity Work at Special Hospitals.

There are two special hospitals in London which have no medical school attached to them and which are not purely hospitals for maternity work, namely, the New Hospital for Women and the French Hospital.

The New Hospital for Women is recognised as available for a portion of the curriculum of the women medical students at the Royal Free Hospital, but it does not serve as a medical school.

The French Hospital takes foreigners who speak French for all forms of illness, maternity work being only one form of its activity. This branch of the work is for in-patients only.

The New Hospital for Women, Euston Road, W.C.
(Borough of St. Pancras).

The maternity work of this hospital forms a small part only of its general work.

Some in-patient cases are taken both for normal and abnormal delivery. There is an out-patient district which is used for training pupil-midwives for the examination of the Central Midwives Board.

District served.—The district embraces a large part of St. Pancras, the south part of Islington, and the west of Finsbury, but there are very few cases in Finsbury.

This area is worked by medical students from University College Hospital and from the Royal Free Hospital, and the Myddleton Square charity works over practically the whole of the area.

In-patient work.—Both normal and abnormal cases are taken, the numbers being about equal.

The number of in-patient cases in 1914 was 44, and in 1915, 42.

Out-patient work.—All women applying are seen by the medical officer appointed for the midwifery work. Medical supervision is exercised up to the time of the confinement, but ante-natal visiting is not carried out.

The doctor in residence goes to all the cases with the midwives who undertake the maternity nursing for the case.

A fee of 5s. is charged and is payable before the confinement. Inquiry is made into the social circumstances of the women who apply for booking, when it appears necessary.

The number of cases attended as out-patients in 1914 was 245, and in 1915, 297.

Post-natal work.—Every patient is instructed to come to the out-patient department with her baby six weeks after the confinement. The mother is examined and the baby weighed and inspected. Any abnormal condition found in either mother or baby is referred to the appropriate department of the hospital.

The French Hospital, Shaftesbury Avenue (Borough of Holborn).

This hospital takes a fair number of maternity in-patient cases each year. In 1914, 50 maternity cases were admitted and there were 41 births, and in 1915, 43 cases with 35 births.

There is no out-patient maternity work.

The British Hospital for Mothers and Babies
(Borough of Woolwich).

This hospital has been formed by the amalgamation of the Home for Mothers and Babies, Wood Street, Woolwich (which served as a training school for midwives under the Council for the Promotion of the Higher Training of Midwives), and the British Lying-in Hospital, formerly in Endell Street, W.C.

Owing to the outbreak of the war it has been impossible to commence the new building, and the hospital occupies the premises of the former Home for Mothers and Babies, which has continued its work uninterruptedly.

Both in-patient and out-patient work is undertaken. Until recently there has also been an out-patient branch in Rotherhithe (Bermondsey), but this is now under private auspices.

District served.—Both in-patient and out-patient work lie almost entirely among the inhabitants of Woolwich, Plumstead, and Greenwich. A few in-patients, however, come from other districts both within and beyond the Metropolitan area.

No other institution works in this district.

In-patient work.—The hospital contains 14 beds, and 185 patients were admitted during the year 1915. The average duration of stay was 20 days.

A charge is made varying according to the financial circumstances of the patient.

Out-patient work.—The hospital has an ante-natal centre with medical supervision which is worked in close co-operation with the Borough Council. The centre is open to any mother, and not only to those who will be attended either in or from the hospital. Ante-natal visiting is also provided.

Maternity nursing forms part of the service.

Fees charged.—Uninsured persons pay 10s. 6d. and others 13s. 6d., but the fees are remitted if necessary.

Post-natal work is not undertaken by the hospital.

The City of London Lying-in Hospital, City Road (Borough of Finsbury, adjoining Borough of Shoreditch).

This hospital is second only to Queen Charlotte's Hospital in the number of its in-patients. It also has an out-patient maternity department worked from the hospital as a centre. The work is carried out by midwives and pupil-midwives, medical students being admitted to the in-patient practice.

District served.—The out-patient district, although nominally extending to a mile radius from the hospital, is mainly confined to Shoreditch.

No medical students work in Shoreditch, but midwifery work is provided in that borough both by the Salvation Army and by the Mission of the Good Shepherd.

The district served for in-patient work is much greater in extent, and numerous cases are received from Islington and Finsbury as well as from Shoreditch. In the years 1914 and 1915 only one Metropolitan borough in each year was unrepresented among the in-patients, and isolated cases came from a number of districts outside London.

In-patient work.—The number of available beds is 61, and the number of cases admitted in 1914 was 1,055, and in 1915, 1,011.

Patients are admitted by letter of recommendation, but many are received at the discretion of the committee alone.

Out-patient work.—This is carried out by pupil-midwives working under trained midwives. All women coming to book are seen

by the midwifery sister, and a large number of them are seen by the doctor as often as may be necessary. All are required to attend at least twice before the confinement.

Although no ante-natal visiting is done, efforts are made to secure adequate provision for the confinement by advising the mother when she attends at the hospital.

Maternity nursing is provided as a part of the duty of the midwife attending the case.

Medical aid, if required, is also provided from the hospital.

Fees charged.—Nil, as for in-patients.

Post-natal work.—A "Babies' Welcome" is held weekly at the hospital for those born under the hospital auspices. The mothers are invited to attend every week for a year.

Clapham Maternity Hospital (Borough of Lambeth).

This hospital is chiefly concerned with in-patient work. All primiparous women are advised to apply for in-patient care, and a number of single women are also taken.

In addition there is a small out-patient maternity department worked from the hospital, and a branch establishment for out-patient maternity work in Battersea. The branch undertakes more out-patient work than is done from the hospital.

District served.—In-patients come mainly from Lambeth, Southwark, Battersea, Wandsworth, and Westminster, but others also from more remote boroughs.

The out-patient work is carried out in Battersea, Lambeth, and a few cases in Wandsworth.

The district in Lambeth is also served by medical students from King's College Hospital, and in a measure by those from St. Thomas's Hospital, but the small size of the Lambeth district work does not admit of appreciable overlapping. No other agencies work in Battersea, except York Road Hospital, indirectly through private midwives.

In-patient work.—About 50 in-patient beds are available, and the number of cases admitted in 1914 was 633, and in 1915, 649. A minimum charge of £1 is made for all cases admitted, and an additional 10s. if there is to be maternity benefit.

Out-patient work.—This is carried out by pupil-midwives, in charge of either a medical woman or a trained midwife. All primiparous women are seen by the doctor and any others who may appear to need special care. Some ante-natal visiting is carried out.

Maternity nursing is undertaken as a part of the midwifery service. In 1915, 74 cases were attended from the hospital and 352 from the Battersea branch.

Fees charged.—The minimum fee for out-patient work is 7s. 6d., which is paid beforehand, and where there is to be maternity benefit an additional 10s. is required—17s. 6d. in all.

Post-natal work.—Some post-natal visiting is undertaken.

The East End Mothers' Lying-in Home (Borough of Stepney).

This institution has both in-patient and out-patient work on a considerable scale.

The district served for out-patient work lies entirely within the borough of Stepney, but in-patients are received from a large number of other boroughs as well as from districts outside London.

The out-patient district is served also by medical students and pupil-midwives from the London Hospital.

In-patient work.—Thirty beds are available and three in the labour wards. In 1914 the number of in-patient cases was 553, and in 1915, 549.

Both normal and abnormal cases are received. The majority of the patients are inhabitants of Stepney, but a number also come from Poplar and some from Bethnal Green. In 1914, 16 other Metropolitan boroughs were represented, and in 1915, 20 others besides the above three, as well as a few other areas.

Fee charged.—This is assessed according to the circumstances of the patient, but appears to be always small in amount.

Out-patient work. A number of the women who apply for out-patient care are seen by the medical officer to the hospital, and general hygienic advice as to habits of life and attention to teeth, etc., is given to all women attending.

Ante-natal visiting is carried out for special cases, and some mothers are referred to one of the neighbouring maternity centres for aid as to the provision of clothing, etc.

Maternity nursing forms a part of the duty of the pupil-midwives.

Medical aid for emergencies is also provided by the hospital.

Fees charged.—This is according to circumstances, and appears to be always low.

Post-natal work is not undertaken, but many of the mothers are referred to one of the numerous infant welfare centres in the neighbourhood.

General Lying-in Hospital, York Road (Borough of Lambeth).

Both in-patient and out-patient work are carried out by the hospital on a large scale. Normal cases are attended by midwives, medical attendance being given from the hospital where needed.

District served.—The in-patients are derived mainly from Lambeth and neighbouring boroughs, but a fair number of cases come from other boroughs and districts outside London.

The out-patient work is carried on in all the adjacent boroughs and also in Westminster. The work in Lambeth and Southwark is in part carried out directly from the hospital. The hospital appoints midwives to do this work at a fixed fee, without charge to the patient. Drugs and medical aid are also provided, if required.

In-patient work.—There are 36 beds, and the number of cases admitted in 1914 was 819, and in 1915, 811.

There is no fixed charge, but the mothers are asked to contribute to the hospital funds from their maternity benefit.

Out-patient work.—This, as already stated, is referred to private midwives appointed by the hospital through letters obtained from subscribers. The women, on application to the hospital, are told to attend the hospital for medical examination during pregnancy,

and if nothing abnormal is found they are referred to whichever midwife employed by the hospital is nearest to their home.

Post-natal work.—An infant consultation is held at the hospital.

Jewish Maternity District Nursing and Sick Room Help Society, Ulderwood Street (Borough of Stepney).

The society has many activities of which all except the district nursing are connected with maternity work.

The main branches are:—

1. In-patient maternity beds, and midwifery training school connected with the above.
2. Maternity nursing in the district for doctors' cases.
3. The provision of women (home or sick-room helps) to look after the home while the mother is laid-by with a confinement.
4. Maternity centre under the L.G.B. regulations, together with systematic home visitation of infants.

1. The in-patient accommodation consists of about ten beds, and although receiving mainly Jewish patients is not only for them. The hospital has received a number of refugees of various nationalities during the war.

The number of cases who received in-patient care was 147 in 1914 and 206 in 1915.

There is at present no out-patient maternity work. This had just been commenced at the outbreak of the war, and has been temporarily deferred.

2. The service is performed for doctors' cases on application, either free or at a low fee.

3. The provision of women trained in housework forms a large part of the work of this society. The mothers apply for their aid some while before the confinement and pay the amount required beforehand in instalments. The payment asked varies with the social circumstances of the mother, but usually lies between 10s. and 20s. for the fortnight.

4. Home visitation of Jewish babies is carried out in co-operation with the local authority, and infant consultations are provided on a large scale. Some ante-natal work is also undertaken.

The Mothers' Hospital, Clapton, N.E. (Borough of Hackney).

This hospital is worked by the Salvation Army, and both in-patient and out-patient maternity work is undertaken.

Pupil-midwives are taken for both branches of the work.

District served.—The in-patients are derived from a number of districts, since it forms the maternity hospital for all the Salvation Army work in London. Many of them are unmarried women, although married women are admitted at their own request.

The out-patient work lies in Hackney, Shoreditch, and Canning Town (West Ham). It is carried on from the hospital, and from two other centres in Hackney, from another centre in Shoreditch, and from a fifth in West Ham.

No medical students work in these districts, but in parts of Hackney the Myddleton Square Maternity Association has a branch out-patient maternity department, and in Shoreditch the Mission of the Good Shepherd is also at work.

In-patient work.—The hospital contains 50 beds, and in 1915 450 women were attended in the hospital. Many of them are received some weeks before the confinement into waiting homes, and remain in the hospital until further arrangements can be made for them.

Out-patient work.—This is undertaken, as above described, from five different centres. In all, in 1915, 1,331 births were attended from these centres. The trained midwives who supervise these centres and instruct the pupils are, in fact, voluntary workers, giving their services to the Salvation Army.

Ante-natal work.—The midwives undertaking out-patient work are at home on certain evenings in the week for their patients who often come up and get advice. Ante-natal visiting is not undertaken.

Fees charged.—The usual fee is 10s. 6d.

Post-natal work.—This is not undertaken.

Queen Charlotte's Hospital (Borough of St. Marylebone).

The general scope of the work of this hospital is well known.

In-patient work on an extensive scale is carried on, and out-patient work on a numerically larger basis than the in-patient work.

Formerly the work was undertaken entirely as a charitable work for the women of the district by trained persons employed by the hospital, but now, although this side of the work has in no sense been altered, the hospital and the out-patient work serves as a training school for a large number of midwives each year.

Medical students are also admitted to the in-patient practice of the hospital.

District served.—The hospital covers a very extensive area through its out-patient work, which serves Marylebone, Paddington, and North Kensington primarily, but extends outwards into Willesden in the county of Middlesex, and northwards towards Hampstead, which is also served.

The great majority of the in-patients are derived from the above-mentioned boroughs, although in-patient cases are received in lesser numbers from practically all the metropolitan boroughs, In 1915 only one of these was unrepresented.

As might be expected, the eastern and south-eastern boroughs send isolated cases only, but a fair number are received from the western boroughs both north and south of the river.

In-patient work.—The number of beds available is 69, and the number of cases admitted in 1914 was 1,787, and in 1915, 1,817. Among the patients are a number of single women, the figure for admissions of this type remaining extremely constant at between 630 to 700 per annum. Many of these doubtless reside in various parts of the country, but are received into homes in the neighbourhood of the hospital while awaiting their confinement.

Out-patient work.—This is carried on by means of three centres of work, one at the hospital, another in North Kensington, and the third to the north which serves Willesden and adjacent parts in Paddington.

These centres are provided entirely by the hospital, and the work is carried out under the supervision of a staff of trained midwives employed by the hospital for this purpose.

All women applying for aid come to the hospital, and a large number of them are seen by the medical officer.

Systematic ante-natal visiting is not undertaken. Maternity nursing is provided as part of the duty of the pupil-midwives.

Medical aid is afforded to any cases needing it in any part of the district by the extern resident medical officer.

The number of cases attended as out-patients from all the centres was 2,068 in 1914, and 2,223 in 1915.

Fee charged.—A fee of 5s. is obtained from persons entitled to receive maternity benefit.

Post-natal work, together with the ante-natal work of a maternity centre, was about to have been commenced at the outbreak of the war and has been of necessity temporarily deferred, but it is hoped it may soon be commenced.

(B) Institutions undertaking out-patient maternity work only.

The Kensington Maternity Association (*Borough of Kensington*).

This association works in North Kensington, and provides a midwifery service in the home for the women of that district.

District served.—North Kensington.

The district is also served by the branch institution from Queen Charlotte's Hospital, and when that department is open it is also served by the medical students from St. Mary's out-patient maternity department.

Midwifery work.—The association has two branches, one midwife being employed at one of them and two at the other.

A considerable amount of attention is devoted to ante-natal work although no home visiting is undertaken. Cases are referred to the nearest ante-natal centre for medical supervision.

Maternity nursing forms part of the midwifery service.

Fees charged.—The fee charged is 17s. 6d. for first cases, and 15s. for other cases.

The number of cases attended by all the midwives in the year is about 300 to 350.

Post-natal work.—The mothers are referred to one of the neighbouring infant welfare centres.

Medical Mission of the Good Shepherd, Hoxton.
(Borough of Shoreditch.)

This mission, in addition to out-patient midwifery work, undertakes the work of a dispensary for children under 14, district nursing, and has an infant welfare centre with home visitation of the children born under the auspices of the mission up to school age.

District served.—Any part of Shoreditch, but the greater number of midwifery cases are from the central and eastern parts.

This district is in great part also served by the pupil-midwives from the City of London Lying-in Hospital, and by the Salvation Army midwives.

Out-patient work.—The number of cases attended in 1915 was 377, the figures showing a tendency to rise on that of previous years. The mothers on booking are seen by the matron, or by one of the midwives, special cases being referred to a neighbouring doctor for advice.

Ante-natal visiting is carried out by the midwives engaged by the Mission for midwifery work. Of these there are three.

Maternity nursing is provided as a part of the midwifery service.

Fees charged.—The fee charged is 10s. 6d., being remitted, if needed, for poor cases.

Post-natal work.—Home visitation of the babies born under the care of the midwifey department is undertaken in co-operation with the Public Health Department of the borough, and an infant welfare centre is also provided.

The Miller Hospital (Borough of Greenwich).

The arrangements for maternity work form a very small part of the work of this hospital.

Until the passing of the Insurance Act, and for a little while afterwards, the hospital employed two midwives, who lived at the hospital, and, through them, provided midwifery aid for poor women in the neighbourhood.

After this, presumably in consequence of the Insurance Act, the number of applications fell so rapidly that the hospital decided no longer to employ their own midwives, but to arrange with local midwives to undertake their cases.

The hospital has now arranged that all subscribers' letters are sent to the almoner of the hospital, who, after investigation, gives these letters to those who apply. The letters are only given if the family are passing through some unfortunate time and want assistance in tiding over the difficulty. All cases are investigated by the almoner.

Cases found to be suitable are then given a letter and referred to the midwife on the hospital list who lives nearest to the mother.

The midwife then enters the case in the ordinary way as one of her own. She receives a fixed fee of 6s. from the hospital, and medical aid is provided free, if needed. There are six midwives, who live in the following boroughs: Greenwich, Deptford, Lewisham, and Woolwich; but no applications have been received from the last for some time. The whole work is on a small scale, and in 1914 only 94 letters were given out.

Myddleton Square Maternity Association.
(Borough of Finsbury, with Branches in the Boroughs of St. Pancras and Hackney.)

This institution undertakes the provision of midwifery or maternity nursing under doctors for poor women in their homes and the training of women for the examination in midwifery of the Central Midwives Board.

Further, in connection with the main house, the association has opened a maternity centre with both ante- and post-natal work, and worked in co-operation with the Borough Council.

In St. Pancras there is also a maternity centre, again worked in co-operation with the Borough Council; this side of the work is commencing in Hackney, and will, it is hoped, be worked likewise in co-operation with the Borough Council's scheme, which is in its early stages.

District served.—The central house in Finsbury works also in Holborn and in the south parts of Islington and St. Pancras, the branch houses in St. Pancras (Oakley Square) and in Hackney (Dunlace Road) taking an area of approximately one mile radius from the home in the respective boroughs concerned.

Medical students from St. Bartholomew's Hospital and from the Royal Free Hospital work in Finsbury and Holborn, and the latter students also in Islington. The medical students from University College Hospital work in this area of Islington and in the whole of the St. Pancras district covered by this association.

A few cases are attended in Finsbury by pupil-midwives from the City of London Lying-in Hospital, and in Hackney the Salvation Army midwives work in parts of the Dunlace Road area.

Midwifery work.—All women coming to apply for aid in their confinement are seen by the matron or by the sister in charge of the midwifery work, and are recommended to attend the antenatal centre for medical supervision.

A large proportion avail themselves of this care.

Ante-natal visiting is carried out in the houses of all the women by the staff of the association in connection with the Finsbury and St. Pancras centres.

Maternity nursing is undertaken as a part of the midwifery service, and the association also undertakes this service for cases attended by doctors or by medical students. In the latter case the service is free, if necessary, but in other cases a fee is charged according to the circumstances of the family.

Medical aid in emergencies is obtained when necessary, and, if possible, some part, at any rate, of the fee is repaid by the mother.

The number of cases atended by this association in the years 1914 and 1915, respectively, were:—

	1914.	1915.
From the Finsbury centre	575 ...	787
From the St. Pancras branch	248 ...	304
From the Hackney branch	172 ...	272
	995	1,363

Fees charged.—A full midwifery fee is 12s. 6d., which is, however, reduced or remitted if necessary. Maternity nursing fee is 5s., but sometimes rather more, or even less.

Post-natal work is undertaken in co-operation with the Borough Councils in Finsbury and St. Pancras, and comprises home visitation and the provision of medical supervision in Finsbury, and home visitation and a baby-weighing is arranged in St. Pancras.

In Hackney the work in this direction is in its infancy.

The Nursing Sisters of St. John-the-Divine.

The central institution consists of a hospital in Lewisham, which undertakes no midwifery work.

There are two branch homes, one in Deptford and one in Poplar, which undertake midwifery in the home and district nursing.

District served.—The branch in Poplar works only in that borough, while that in Deptford also works to some extent in Greenwich.

No other institution works in these districts.

Deptford branch.—The number of cases attended from this branch in 1914 was 335, and in 1915, 325. The figure remains very fairly constant from year to year. The work is carried out by two midwives employed for the purpose.

The fee charged is 10s. for all cases, except for first babies, when the fee is 12s. 6d. The fee is usually paid in instalments before the confinement, and the women receive general advice when they come to book and also when they come up to pay the instalments. Special cases are sent to a doctor.

Ante-natal visiting is not carried out.

Medical aid in emergencies is obtained and the fee paid, but, if possible, recovered from the patient.

Maternity nursing is carried out as part of the midwifery service.

Post-natal work is not undertaken.

Poplar branch.—The number of cases attended from this branch is about 550 per annum, 535 being attended in 1915.

The work is carried out by two trained midwives and two pupil-midwives. In other respects the work is the same as at the Deptford branch.

Ormond Home, 155, *King's Road, S.W.* (*Borough of Chelsea*).

This institution undertakes midwifery work for women in their homes and trains pupil-midwives.

District served.—Chelsea and the western parts of Westminster. This district is also served by the medical students from St. George's Hospital, and in Westminster by those from the Westminster Hospital. No other midwifery institution works in this area, except the York Road Hospital indirectly through a private midwife, although the practice in this area is not large.

Midwifery work.—The women on coming to book are seen by the matron and are advised to attend the ante-natal centre in the neighbourhood. Ante-natal home visiting is also carried out, and

the women are encouraged to come up frequently for advice. Maternity nursing is a part of the midwifery service.

Fees charged.—From 12s. 6d. upwards. It is difficult to assess the number of cases attended, as the institution has recently undergone reconstruction. The number is probably about 200.

Post-natal work is not undertaken.

The Royal Maternity Charity, Finsbury Square.

This charity is an old-established one. It provides free midwifery service by means of letters, the possession of which is obtained by subscription to the charity.

The subscribers bestow the letters on whom they will, and no further investigation is required.

The charity has a list of midwives, who are in private practice in various parts of London and just outside London. The midwives are paid 6s. per case sent on to them on behalf of the charity. The necessary drugs are provided by the charity, and also a maternity bag for use in the cases taken under the charity. Medical aid in emergency cases is also provided and paid for by the charity.

Between 800 and 1,000 cases are attended by this method, the number having fallen very greatly since the passing of the Insurance Act.

The charity will also train midwives through some of the midwives on its list.

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LOCAL GOVERNMENT BOARD,
Whitehall,
April, 1917.

To the Right Honourable Lord Rhondda, President of the Local Government Board.

MY LORD,

Dr. Coutts in the following report gives particulars of a number of cases of Anthrax of unusual origin, the circumstances of which were investigated by him and by others. Most of these were cases of external Anthrax, but in a few the Anthrax appeared to be generalised from the onset. The lesion in nearly all the cases was situated in the shaving area of the face and neck.

The cases were ascribable with a high degree of probability to the use of cheap shaving brushes, in some of which the presence of living anthrax bacilli was demonstrated.

The cases of Anthrax occurring among civilians, in which either there was definite proof or strong suspicion of infection by the use of shaving brushes, ranged over a number of months:

1915—June, 3 cases.
July, 1 case.
December, 2 cases.
1916—January, 1 case.
March, 3 cases.
May, 1 case.
August, 3 cases.
September, 2 cases.
October, 3 cases.

Amongst soldiers, 18 cases of Anthrax occurred in England since August, 1914, and 28 in France. Some of these were undoubtedly due to infection from shaving brushes.

Suspicion was first drawn to shaving brushes as a cause of Anthrax by an investigation by Dr. Elworthy, pathologist to the West London Hospital, into a case of Anthrax occurring in July, 1915, the particulars of which were reported to the Board in the following month.

Dr. Elworthy's investigation showed clearly that the infection was due to the use by the patient of a recently purchased shaving brush. This was a cheap brush of imitation badger hair with a bone handle. Dr. Elworthy proved the presence of virulent anthrax spores in the brush used by the patient, also in several unused brushes of the same pattern purchased at the shop where the original brush was obtained. Another case of Anthrax occurring about the same time was also traced to the use of an infected shaving brush purchased from a different shop. On tracing the origin of the brushes, it was found that they all came from one wholesale dealer and were manufactured in a single factory.

Inquiries made on behalf of the Board by Dr. Coutts, in association with Dr. Collis of the Factory Department of the Home Office, showed that the hair used in making these brushes

(4750.) Wt. 52448—518. 750. 6/17. J. T. & S., Ltd. G. 14. Sch. 17.

consisted in great part of Chinese horse hair, and that this hair had not been disinfected before being manufactured into brushes. The remaining unmanufactured hair from the same source was found to be largely infected with anthrax spores.

The manufacturer explained that the hair was invoiced to him as "Goat's Hair," which does not come under the Home Office Regulations (see p. 4), and that for this reason he had not subjected it to disinfection.

Immediate steps were taken to disinfect the materials at the factory and to recall and destroy brushes of the consignment known to have been made from infected hair. The manufacturer undertook in future to use none but disinfected hair in the manufacture of shaving brushes.

Of the civilian cases of Anthrax subsequent to the two mentioned above no less than seven were traced to the manufacturer implicated in these cases. In most of the seven it was either definitely proved or was probable that the brushes had been made before the end of August, 1915, and there was therefore no reason to suspect that the arrangements for disinfection had failed. In one or two instances, however, brushes have been found to contain anthrax spores, although the evidence pointed to disinfection having been carried out. Experiments have been made by Dr. Eastwood in the Board's pathological laboratory, and are being continued, to ascertain what precise conditions must be fulfilled to ensure sterilisation of horse hair.

In three further cases shaving brushes infected with Anthrax were traced to manufacturers in this country, other than the manufacturer concerned in the first cases.

In addition to the above cases, in which shaving brushes manufactured in England were implicated, there were four further cases of Anthrax traceable to brushes of foreign manufacture. Of these cases two occurred in soldiers, and were due to infected brushes forming part of a large consignment from Canada. The brushes in this consignment had been made in New York. In two further cases the infected brushes came from New York. One consignment of shaving brushes from Japan was found to be heavily infected with Anthrax.

The full details given in Dr. Coutts' report show that, although the danger of Anthrax from infected shaving brushes is limited in extent, it constitutes an appreciable risk which ought to be removed.

The Board have under consideration what administrative action is required to secure that hair used in the manufacture of shaving brushes in this country is satisfactorily sterilised before the brushes are manufactured. It will be necessary also to secure that imported brushes are similarly free from infection. For this purpose a guarantee of origin may be desirable as well as examination of samples of brushes after importation.

I am, my Lord,

Your obedient servant,

ARTHUR NEWSHOLME,

Medical Officer.

Report to the Local Government Board on an inquiry into cases of Anthrax (malignant pustule or external anthrax) suspected to be due to the use of infected shaving brushes.

By Francis J. H. Coutts, M.D., B.Sc.

During 1915-16 a considerable number of cases of Anthrax occurred in persons not engaged in occupations recognised as liable to be associated with Anthrax. In a fairly large proportion of the civil cases investigated evidence of a more or less conclusive character was forthcoming that the infection had been acquired owing to the use of shaving brushes infected with Anthrax spores.

Various circumstances tended to make it extremely difficult to obtain conclusive evidence in some instances that infection was due to the use of shaving brushes. This was particularly so with regard to most of the military cases.

But the cumulative evidence affords strong grounds of suspicion that in a large majority of the cases summarised in the appended tables an infected shaving brush was the source of the infection.

There are some elements of doubt with regard to civil cases No. 3 and No. 10, but there are circumstances which seem to justify their inclusion in the table.

Of the military cases, there were grounds for suspecting that case No. 10 was due to the handling of infected hides, whilst there was a history of association with cattle in case No. 3 and with horses in case No. 6. In neither of these latter cases was there any known disease in the cattle or horses. In case No. 4 blankets were suspected locally as the source of infection at the time of occurrence of the case, but no definite evidence was forthcoming.

The first intimation which reached the Board that shaving brushes were causing Anthrax infection was in August, 1915, when the medical department of the Board were informed of some investigations by Dr. Elworthy.

These have been recorded in the *Lancet* of January 1, 1916. Great credit is due to Dr. Elworthy for the acumen which led him to suspect the shaving brush as a source of infection and for the perseverance with which he followed up the investigation.

The case which led to the discovery of this novel mode of infection by Anthrax was No. 1 in the annexed table of civil cases. The patient was a solicitor's clerk, who was admitted to the West London Hospital on July 1st, 1915, with Anthrax of the neck. The lesion was first noticed by the patient on June 29th, and he died in hospital on the morning of July 2nd. Post-mortem examination showed Anthrax infection, which had entered the blood-stream through the lesion in the neck.

As a result of careful inquiries, it transpired that a relative of the patient had recently presented him with a new shaving brush, which he had only used on one or two occasions. Dr. Elworthy obtained the incriminated brush and found that virulent Anthrax spores were present. The bacteriological findings were corroborated by animal inoculation.

It was, of course, conceivable that the Anthrax had been derived from some other source and conveyed from the lesion to the patient's shaving brush. Dr. Elworthy therefore obtained from the shop where the original brush was purchased five other unused brushes of the same pattern and belonging to the same consignment. He proved the presence of Anthrax bacilli in four out of five of these brushes. The chain of evidence was therefore complete. It was fortunate that, in this first instance in which suspicion was directed to a shaving brush, the patient's brush was forthcoming, and that prior to examination it had not been used sufficiently often for the contaminating Anthrax spores to be washed away.

Another case occurring about the same time gave valuable confirmatory evidence. A hawker in Deptford (case No. 2 in table) purchased a shaving brush on June 20th, 1915; on June 27th a lesion appeared on his cheek, which developed slowly. He came under observation on July 13th, and was removed to the London Hospital on July 17th, being discharged cured on August 23rd.

Dr. Elworthy obtained possession of the patient's brush, and, after failing to find Anthrax bacilli in the free portion of the hair, discovered them in the ends of the hair embedded in the cement fixing the brush to the handle. Evidently the cleansing of the shaving brush by repeated use had washed off the Anthrax bacilli from the free part of the brush.

Two other brushes of the same pattern obtained at the shop where the original brush was purchased by the Deptford patient were also found to be infected with Anthrax spores.

It was ascertained that the retailer in Kensington who supplied the brush in case No. 1 and the retailer in Deptford who had supplied the brush to case No. 2 had both received shaving brushes of the incriminated pattern from the same wholesale merchant, who may be designated "A." On visiting this merchant's premises with Dr. Collis, one of the Medical Inspectors of Factories of the Home Office, and Dr. Ross, of the London County Council, we found that over 25 gross of brushes of this particular pattern had been distributed to various firms between March 22nd and August 11th, 1915. A list was obtained of the names and addresses of the firms supplied, along with a statement of the quantity supplied to each. The officials of the London County Council undertook to deal with the consignments delivered to London retailers, whilst medical inspectors of the Board traced the consignments supplied to retailers in the provinces. Communications were sent to the Local Government Boards in Scotland and Ireland with respect to consignments sent to Glasgow, Dublin, and Belfast.

It was ascertained that two of the London firms supplied by the wholesaler "A" had sent brushes to New Zealand, Brisbane, and Sydney, and steps were taken with regard to these, Dr. Howarth, M.O.H. for the City of London, bringing the facts before the High Commissioners for Australia and New Zealand.

It may be said at once that although a considerable number of the brushes were traced and destroyed, many had already been sold to private purchasers, and it was impossible to trace these. Although there was good reason to suppose that a very considerable proportion of these brushes were Anthrax-infected, fortunately transference of the disease to users of the brushes was comparatively rare.

It remained to discover how infected hair came to be used in the manufacture of shaving brushes. The wholesale firm "A" stated that on the outbreak of war they were unable to get the cheap shaving brushes formerly obtained from Germany (Leipsic and Nuremberg). They therefore bought some "goats' hair" and sent this to a manufacturer in the Midlands (firm "B"), who made the hair into shaving brushes and sold the brushes back to firm "A."

The so-called "goats' hair" was purchased by firm "A" from a broker "C" in September, 1914. The broker "C" admitted that the hair was invoiced to firm "A" as "goats' hair," but stated that the so-called "goats' hair" was usually a mixture of goats' hair (beards and tails) and horsehair (manes and tails). This cheap hair might be a mixture of the hair of various animals. The consignment sold early in September, 1914, to firm "A," and invoiced as "goats' hair," was part of a lot purchased in December, 1912, and held in stock, inasmuch as before the war there was little demand in England for this cheap hair.

Subsequent consignments from broker "C" to firm "A," in September, 1914, and April, 1915, were invoiced "goat and horse hair," but it does not appear that firm "A" ever informed manufacturer "B" that the hair consisted partly of horsehair. The consignment of which the parcel invoiced "goats' hair" formed part came from a firm in Tientsin, China (firm "D"). The later consignments, invoiced "goat and horse hair," came from firm "E," in Tientsin, China. Practically all this so-called "goats' hair" comes from China, and consists largely of horsehair. I was informed that London has been the principal market for the trade in China "hair," and that prior to the war the great majority of it was re-exported to Belgium, Germany, France, and America. I was further told that English manufacturers before the war avoided the use of this material* either because it was known to be liable to be infected with Anthrax

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* In September, 1899, the principal English manufacturers using horsehair agreed not to buy Russian, Siberian or Chinese undyed mane hair unless satisfactory guarantees as to disinfection were given. *See* Annual Report of Chief Inspector of Factories and Workshops for 1899, p. 323.

or to avoid difficulties in connection with the Home Office Regulations.* On the outbreak of war there was such a demand for brushes of all descriptions (including shaving brushes, clothes brushes, horse brushes, &c.) that manufacturers had to use this Chinese material. Besides the parcels sold to firm "A," broker "C" had sold hair from the same consignment to various people in this country and in America.

Having discovered that the incriminated shaving brushes had been made from cheap Chinese hair consisting largely of horsehair, the source of the Anthrax was clear, as horsehair from China is well known to be liable to be infected with Anthrax.† The next question was why the manufacturer failed to disinfect the hair before making it into shaving brushes, in view of the Home Office Regulations.

Dr. Collis, of the Home Office, visited manufacturer "B," and was informed by him that the consignments of hair sent by firm "A" were all invoiced as "goats' hair." Dr. Collis verified this statement by an examination of the invoices. The manufacturer "B" stated that he was aware of the Home Office Regulations with regard to the disinfection of horsehair from China, Siberia, or Russia, but there were no similar regulations for goats' hair, and, as the material from firm "A" was in-

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* *Home Office—Statutory Rules and Orders*, 1907—*No.* 984.

These Regulations among other things require in all factories and workshops disinfection, by one or other of two defined procedures, of all horsehair from China, Siberia or Russia, whether in the raw state or partially or wholly prepared.

"Disinfection" means—

(*a*) exposure to steam at a temperature not less than 212° F. for at least half an hour, of material so loosened, spread out or exposed as to allow the steam to penetrate throughout; *or*

(*b*) exposure of material to such disinfectant under such conditions of concentration and temperature of the disinfectant, and duration and manner of exposure of the material to it, and otherwise, as are certified to secure the destruction of anthrax spores in all parts of all horsehair subjected to the process. Provided that such a certificate shall have no force unless and until (1) a copy of it has been submitted to the Secretary of State, and (2) a copy of it is kept in the Register required under Regulation 1. Provided, further, that any such certificate may at any time be disallowed by the Secretary of State, either generally or with regard to a factory or workshop in which anthrax has occurred.

"Certified" means certified by the director of a bacteriological laboratory recognised by a corporation in the United Kingdom having power to grant diplomas registrable under the Medical Acts, 1858 to 1905.

Further, a register of material (as defined) has to be kept by the occupier, containing particulars which have been prescribed by the Secretary of State, as follows:—(1) weight of material; (2) date of receipt on the premises; (3) country of origin; (4) whether raw, or partially, or wholly prepared; (5) method of disinfection, and in the case of material disinfected on the premises; (6) the date of disinfection, and in the case of material disinfected elsewhere than on the premises; (7) the name of the person from whom the "material" was obtained.

† *See* Reports by Dr. Legge in Annual Reports of Chief Inspector of Factories and Workshops for 1899, p. 323; 1904, p. 328. Also Dr. Legge's Milroy Lectures on Industrial Anthrax—*Lancet*, 1905 (1), pp. 689, 765, 841.

voiced as goats' hair, he felt free to manufacture it into shaving brushes without disinfection.

As the invoices bore out the manufacturer's statement, no proceedings could be taken against him for failure to take the precautions mentioned in the Home Office Regulations.

Dr. Collis obtained samples of the hair in stock in the factory, and this was examined by Dr. Eastwood, the Board's bacteriologist.* It was found to be very dirty and heavily contaminated with anthrax spores. The hair remaining in the factory was disinfected, and a subsequent examination of part of it by Dr. Eastwood showed that the anthrax spores had been destroyed.

As the information detailed above indicated that infected hair had been used for some time for making brushes, it was thought well to look into other cases of Anthrax which had come to the knowledge† of the Local Government Board as having occurred recently, and were not obviously connected with some of the more usual sources of Anthrax infection, *e.g.*, wool, hides, Anthrax in cattle, &c.

The following cases may be mentioned:—

A man, J. W., died in October, 1914, from Anthrax, after an injury to the eyelid. His wife carried on brushmaking at home in Southwark, using white and black hair from Russia and China. The black hair was certified to have been steam-disinfected. The white hair could not be so treated, but was said to have been exposed to the action of formalin vapour. A woman in November, 1914, was attacked by Anthrax of the face. She was making military boot brushes at home, using Chinese grey hair. These cases have not been included in Table I., but the next two cases have.

Case 3.—A burner man at a copper ore furnace developed Anthrax on the back of the neck about July 22nd, 1915. At first no source of infection could be traced, but at a later date further inquiries were made, and on examining the man's shaving brush anthrax bacilli were found by Dr. Elworthy. The brushes were made by manufacturer "F" from Chinese grey drafts. Some of the parcel of hair from which these brushes were made was tested by the Board's bacteriologist, and found to cause Anthrax in animals. This hair was certified to be disinfected, but evidence was obtained throwing some doubt on the statement as to disinfection. As no anthrax bacilli were found in a companion brush obtained from the same retailer, and as the back of the neck is not a usual site for shaving-brush anthrax, this case remains obscure.

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* The technique used in testing for anthrax is described in Appendix 2 to the Report of the Board's Medical Officer for 1915–16.

† Under the Factory and Workshop Act a medical practitioner must report to the Home Office every case of anthrax contracted in a factory or workshop, but there is no general compulsory notification of anthrax in man. Cases come to the knowledge of the Board accidentally, *e.g.*, from notices in the Press; through the courtesy of medical practitioners, or medical officers of health; or from the Chief Inspector of Factories in regard to cases reported to him in which there is no evidence that the disease was contracted in a factory or workshop.

Case 4.—A stationary engine worker, living in Southall, purchased a shaving brush about the beginning of June, 1915, from a chemist's shop. On June 16th he had a pustule on the cheek, and was admitted to St. Mary's Hospital, Paddington, being discharged cured on August 4th. The patient himself suspected that the shaving brush might have been responsible, and had it destroyed. Two similar brushes obtained from the same chemist's shop were found by Dr. Eastwood to be infected with Anthrax. On further investigation, it was ascertained that the retailer obtained the brushes on May 4th, 1915, from a wholesale firm, "G," who had received them from manufacturer "B," *i.e.*, the same manufacturer who was responsible for the brushes implicated in cases 1 and 2.

Besides the cases already mentioned, further cases of Anthrax have been reported which have been attributed to infected shaving brushes, and the circumstances connected with some of these may be briefly set out:—

Case 5.—About November 25th, 1915, a man in Coventry* purchased a shaving brush from a firm in that town. On December 3rd a malignant pustule appeared at the angle of the lower jaw and he died on December 7th. The brush used by the patient was found to be infected with Anthrax. An examination of four similar brushes from the same shop gave negative results, but on obtaining further samples, two brushes were found to contain virulent anthrax spores. The retailer in Coventry obtained the brushes from a wholesale firm in London "H." This firm were supplied by manufacturer "B," the same manufacturer as was concerned in Cases Nos. 1, 2 and 4. Brushes of this particular pattern had been supplied to firm "H" by manufacturer "B" on August 16th, September 16th, October 13th, 22nd, and 28th, 1915. Firm B, on being visited by the District Inspector of Factories, declared that since Dr. Collis's visit in August, none but disinfected hair had been used by them. It seemed probable that the Coventry firm had been supplied from some of the later consignments, but on further inquiry, it was ascertained that it was possible that a box or two of the earlier (August) consignment had been kept over by Firm H and delivered to the Coventry firm. It may be stated here that it was unusual to find arrangements made by wholesale firms for methodically storing and dealing with shaving brushes, so as to make it possible to identify a brush with certainty as belonging to a particular consignment.

On the whole it was thought more likely that the infection in this case had been derived from a consignment manufactured before Dr. Collis's visit to firm "B" in August, 1915, than that a failure of disinfection had occurred.

In *Case* 6 the site of the lesion suggested shaving-brush infection, but no definite evidence could be obtained.

Case 7.—A gasworker in Torquay developed a malignant pustule in the shaving area (right side) on January 22nd, 1916. The

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* See *Lancet*, January 29th, 1916.

pustule was excised on the 24th and the patient treated with Sclavo's serum. It transpired that his wife had purchased a shaving brush for him at a shop in Bath on January 8th, and the man had used this brush on three occasions. Through the kindness of Dr. Symons (M.O.H., Bath), samples of shaving brushes were obtained at the shop in Bath and one pattern (imitation badger hair) was found to be identical with the brush bought by the patient, and I recognised it, when received, as being of the same design as in the Coventry case. Two of the brushes from Bath of this pattern were found by Dr. Eastwood to contain Anthrax spores. The actual shaving brush used by the patient was examined by a bacteriologist who found organisms "morphologically indistinguishable" from Anthrax. Unfortunately confirmation by animal inoculation was not practicable.

The pattern of the brush suggested that firm "H" was again involved, and although the retailers in Bath were not able to state positively the date on which the consignment of brushes was received, it was ascertained from a list they provided of firms from whom they had bought shaving brushes that firm "H" had supplied those in question. Presumably this outbreak was also due to brushes manufactured by firm "B" prior to August 21st, 1915.

Case 8.—A man in Glasgow bought a shaving brush on March 7th, 1916. On March 11th he found a pimple on his neck which developed into a swelling, and the patient died on March 15th.

The shaving brush used by the patient and a companion brush from the same retailer were proved by animal inoculation to contain Anthrax spores (Glasgow bacteriologist). The consignment of brushes was sold to the Glasgow retailer by a London firm "J" on May 25th, 1915, so that they had been in stock a long time. On making inquiries I found that the brushes were made by firm "K" in April or May, 1915, partly from hair supplied to them by firm "J" and partly from China horsehair from a London dealer "L." I saw the invoice for the latter and it had a guarantee of disinfection. On visiting firm "L" I was assured by them that this particular package of hair had been disinfected in the steam disinfector of a London borough council.

Firm "J" declared that the hair they supplied to the manufacturer "K" had also been accompanied by a certificate of disinfection.

Case 9.—A greaser on the South-Eastern and Chatham Railway, living at Folkestone, bought a shaving brush on March 10th, 1916. On March 16th he developed a malignant pustule on the right cheek. The shaving brush was examined by Dr. Eastwood and found to contain Anthrax spores. There was some difficulty in tracing the source of this brush. It was at first attributed to firm "H," who had supplied the Folkestone retailer with similar brushes, but ultimately it was traced to firm "M," a London merchant, who sold to the Folkestone retailer on November 19th, 1915, one dozen of a parcel of three gross of this particular pattern purchased from manufacturer "B" on July

29th, 1915. Two out of five brushes remaining of this pattern were obtained from firm "M," and Dr. Eastwood reported them to contain Anthrax spores. The dates of delivery from manufacturer to wholesaler indicated pretty conclusively that the outbreak in this case was connected with brushes made by manufacturer "B" before the warning given him by Dr. Collis as to the necessity for disinfection of hair.

Cases 10 and 11 may conveniently be considered together, since information obtained when investigating case 11 seemed to throw some light on the source of the disease in case 10.

Case 11.—An engineer in Birmingham came under observation on May 2nd, 1916, with a malignant pustule in the shaving area of the neck. He had purchased a new shaving brush shortly before this and used it twice only. Professor Leith obtained virulent Anthrax bacilli from the lesion, and found an organism resembling Anthrax in the shaving brush. This organism, however, showed slight morphological differences from typical Anthrax. Dr. Eastwood, however, recovered typical Anthrax bacilli from one of two brushes of the same pattern as that supplied to the patient and obtained from the same shop. The other brush was negative as regards Anthrax. Inquiries showed that the brushes came from a dealer in Sheffield "N," but they were made by manufacturer "B," whose goods were implicated in previous cases.

Inquiries by Dr. Scurfield in Sheffield appeared to indicate that the infected brushes formed part of a consignment of 24 dozen dispatched by the manufacturer to Sheffield on October 8th, 1915, i.e., subsequently to the warning given as to the necessity of disinfection. Dr. Collis therefore revisited the factory, and was informed that from the time of his previous visit in 1915 none but disinfected hair had been used in making brushes. The invoices for hair supplied confirmed this, and Dr. Collis was satisfied that the destruction of manufactured brushes remaining on hand in August, 1915, was properly carried out, and that all unmanufactured hair on the premises at that time was adequately disinfected.

He ascertained, however, that prior to October 8th, 1915, consignments of shaving brushes had been sent by firm "B" to firm "N," viz., on the 17th July, 1915, 13th and 26th August, 1915, and 18th September, 1915. Further inquiries from firm "N" elicited the fact that it was quite possible that various consignments of this pattern of brush had been mixed up on their premises and that the Birmingham retailer may have been supplied from a portion of a consignment received from firm "B" before the end of August, 1915. One could not therefore come to the conclusion that there had been any failure on the part of firm "B" to take precautions as to disinfection.

Shortly before the investigation of the Birmingham case Dr. Scurfield, of Sheffield, had reported a fatal case of Anthrax in a meter inspector (Case 10), the Anthrax bacillus being recovered post mortem by Professor Douglas. No source of the disease could at the time be discovered. The shaving brush—said to

have been an old one—was examined by Professor Douglas, with negative results. Whilst inquiries were being made on the premises of firm "N" in connection with the investigation of the Birmingham case No. 11, it transpired that the daughter of Case 10 was a warehouse girl handling the shaving brushes which were concerned with Case 11. The girl stated that her father had not used a shaving-brush from the stock of firm "N," and the possibility was suggested of infection being conveyed on the hands of the girl. The coincidence is certainly striking.

Case 12.—Early in August, 1916, a patient was treated in hospital in Glasgow for Anthrax of the cheek, which was attributed to a shaving brush which was used by him up to within three days of the development of symptoms. Anthrax organisms were recovered from the lesion by the Glasgow bacteriologist, who also proved by animal inoculation the presence of Anthrax spores in other shaving brushes of the same origin. The brush was one of $1\frac{1}{2}$ gross made by a firm in Glasgow—firm "O"—from hair invoiced to them by a Sheffield firm, "P," on September 1, 1915. The hair was stated to have been Siberian horse-tail hair obtained from firm "Q," but was disinfected by firm "P," who supplied a certificate of disinfection to the Glasgow firm "O." Disinfection was carried out by immersion of the hair "in a 2 per cent. solution of cyllin in accordance with one of the methods recommended by Dr. Klein in a certificate addressed to the Home Office, dated 10th June, 1912."

It may be noted as a matter of interest that part of one of the original consignments of Chinese hair purchased by broker "C," and referred to in the notes on Cases 1 and 2, went to firm "O" in Glasgow through an intermediary merchant. Our information was to the effect that as no certificate of disinfection accompanied the parcel it was returned for the purpose of disinfection, except for a portion which had already been used. Neither disinfected nor undisinfected portion was used for the manufacture of shaving brushes.

Case 13 was one of special interest in that it disclosed a new source of infected shaving brushes and also because the administrative action taken resulted in the withdrawal from sale and the destruction of a very large number of heavily infected brushes.

A young man was admitted on August 6th, 1916, to the Sheffield Infirmary with a malignant pustule on the chin. Film preparations from the lesion examined at the infirmary showed Anthrax bacilli. The father volunteered the information that the disease was caused by shaving. The mother had bought the boy a new shaving-brush, price $1\frac{1}{2}$d., in the market. This was used for the first time on August 2nd. He cut a pimple while shaving, and a boil developed next day. The brush was unfortunately destroyed. Inquiries by Dr. Scurfield revealed the fact that the brush was bought from a stall rented by firm "R," whose headquarters were in Bolton. It was ascertained that this firm obtained the brushes from a London merchant, "S." I visited this firm and obtained the following information.

The firm are wholesale dealers in many kinds of toys and fancy goods. Prior to the war they had obtained from Germany cheap shaving-brushes to be sold on market stalls and at penny bazaars at or about the price of 1d. On the outbreak of war the firm looked out for another source of supply, and on a visit to Japan the principal of the firm arranged for brushes to be made by a Japanese firm in Osaka, similar to the German brushes previously supplied by firm "S." The brush consisted of a rather thin bundle of grey or yellowish white hair cemented into a black lacquered wooden handle.

The Osaka manufacturers shipped the brushes through agents in Kobe. The brushes arrived in London in cases containing either 50 gross or 30 gross, and the cases were not opened in London, but dispatched intact to customers in this country.

In all, the merchant "S" had only received eight cases of these brushes, three containing 50 gross in each and five containing 30 gross. One case of 30 gross had been sold to firm "R." Four other cases had been dispatched to three separate firms in Manchester, one case to a firm in Warrington, one to a firm in Newcastle-on-Tyne, and one to a firm in Paisley. The firms concerned had a large number of branches in other towns all over the country, but obviously the best way of dealing with the matter was through the headquarters of the firms concerned.

I communicated, therefore, with the Medical Officers of Health of the towns mentioned, who took prompt action to recover all the unsold brushes both from the headquarters of the firms concerned and also from all their branches throughout the country. As a result of the energetic action taken by the Medical Officers of Health a very large proportion of the total number of brushes imported were withdrawn from sale and destroyed. By the 1st September, 1916, there was information of the recovery of over 30,000 brushes out of the 43,200 imported. The exact figures on this point relate to seven only out of the eight original packages, and there is reason to believe that a considerable number out of the remaining package of 50 gross have been destroyed.

Dr. Eastwood examined samples of brushes from four out of the eight packages imported. He found typical Anthrax bacilli virulent to guinea-pigs in every brush examined, the hair being found very dirty and heavily infected with Anthrax. Of the consignment which included the brush suspected to have caused the disease in Case 13 he examined separately three brushes from those recovered in Sheffield and two of the same consignment obtained from the headquarters of the firm "R" in Bolton. In every one of these brushes virulent Anthrax spores were present.

Professor Delépine, of Manchester, found virulent Anthrax spores present in large numbers in brushes from consignments sent to Manchester, and also in the brushes consigned to the Warrington firm.

The whole evidence indicated that these Japanese consignments were heavily infected, and the Board therefore communicated

with the Foreign Office with a view to representations being made to the Japanese Government requesting them to take steps to secure the disinfection of hair used in the manufacture of shaving brushes or other brushes liable to come into direct contact with human beings.

Case 14.—An electrician 36 years of age died on September 1st, 1916, at Leslie, Fife, from malignant pustule. The lesion was situated in front of the right ear, and was attributed by the doctor attending the patient to infection from a shaving brush purchased in Glasgow a few days before the development of the lesion. The suspected shaving brush was destroyed by the patient's wife, and information as to the origin of the brush was unobtainable.

Case 15.—On September 30th, 1916, a clergyman in Mossley died from Anthrax. The original lesion, under the chin, was first noticed on September 21st. On September 14th the deceased purchased a shaving brush in Blackpool. The brush was stated to have had black bristles and a black handle. It was only used once, because it was too soft. Unfortunately it was then destroyed. Inquiries made by the M.O.H. of Blackpool indicated that the brush had been obtained from the headquarters of the firm "T" in Liverpool. Dr. Hope kindly ascertained for me that this firm obtained shaving brushes from Paris and from a London merchant, "V."

I visited firm "V," and was informed that they supplied 1 gross 7 dozen shaving brushes to firm "T" in June, 1916. These shaving brushes had *black* handles and imitation *badger-hair* brush, and were obtained from a firm in New York ("W").

Dr. Eatough, M.O.H., Mossley, kindly made some further inquiries, and although the description by members of the patient's household of the brush bought by the deceased did not correspond precisely with the appearance of a sample brush obtained by Dr. Hope, of Liverpool, from the firm "T," the evidence on the whole suggested that the incriminated brush was part of this consignment. The Paris brushes had yellowish bristles set in a handle made partly of boxwood and partly of white metal. Further examination by Dr. Eastwood of the sample brush from firm "T" revealed the presence of Anthrax spores. Similar brushes from the same source obtained later from another Liverpool firm were also found infected with Anthrax. The wholesale firm "V" informed me that they had communicated with the New York manufacturers, urging them to take steps to have all hair used in the manufacture of shaving brushes adequately disinfected.

Case 16 presented some interesting features. A silk manufacturer residing in Halifax purchased a safety razor set from a shop in London on August 28th, 1916. During September he developed a malignant pustule on the neck (right side). His doctor, suspecting the shaving brush to be the source of infection, sent the brush to Dr. Eurich, who found Anthrax bacilli present. The safety razor set contained a shaving brush with white bone

handle and imitation badger-hair brush. The sets were made up by a Birmingham firm, who purchased the shaving brushes from the London merchants ("H").

On visiting the firm "H" I found that the pattern of brush concerned was the same as that implicated in the Coventry and Torquay cases. The brushes were manufactured by manufacturer "B." The remainder of the "sets" in the London shop (about a dozen) had been returned to the Birmingham firm, and through Dr. Robertson's good offices the shaving brushes were sent up for bacteriological examination. Two of them were examined by Dr. Eastwood. One of them was proved by animal inoculation and by culture to contain Anthrax spores. The other was very free of organisms of any kind.

The firm from whose branch shop in London the safety razor set was bought declared that the safety razor set sold on August 28th, 1916, was received by them from Birmingham not earlier than April, 1916. Inquiries from firm "H" indicated that consignments of this pattern of brush were received from manufacturer "B" on August 24th, 1915, October 22nd, 1915, and October 28th, 1915, and were sent on to the Birmingham firm in each instance within a few days.

The manufacturer declared that the consignments of October 22nd and October 28th had undoubtedly been made from hair which had been thoroughly disinfected, and they suggested that the infected brush must have belonged to the August 24th parcel which had been manufactured and sent out before Dr. Collis's warning had been received.

Case 17.—A labourer at a gunpowder works, who was also employed in cleaning out ditches and watercourses, noticed a swelling of the left cheek on October 23rd, 1916. He was very ill on the 28th with fits of shivering. On the 29th he saw a doctor for the first time. The following day he became delirious and died. The pustule was on the left side of the jaw, and post mortem Anthrax bacilli were found in the lesion.

His daughter bought him a shaving brush (bone handle with imitation badger-hair brush) at Eastbourne in the week ending October 7th. The brush was obtained through the kindness of Dr. Pierce, M.O.H. of Guildford Rural District, and examined by Dr. Eastwood. Inasmuch as it had been used by the deceased after the development of the pustule, the brush might have been contaminated from the pustule. Dr. Eastwood found, however, that the free part of the brush did not contain Anthrax spores, but by melting out the cement from the handle of the brush he was able to examine the portions of the hair which had been embedded in the cement and could not therefore have been infected from the lesion in the patient. Anthrax spores were found in this hair, so that there is strong evidence that the brush was infected before being used by the patient, and was the cause of the disease.

The Acting M.O.H. of Eastbourne kindly obtained from the Eastbourne retailer samples of brushes of the same pattern as

that used by the deceased. These brushes were made of imitation badger hair set in bone handles. Of four brushes sent two were of identical size to that used by the deceased; one was smaller and one was larger. Dr. Eastwood obtained proof of the presence of Anthrax spores in the medium-sized and large brushes, but not in the smaller one.

The brushes were purchased by the Eastbourne retailer from a London merchant ("X"). On visiting his premises I ascertained that these brushes had been sent to the Eastbourne retailer in June, 1915, and formed seven-eighths of a small consignment received from manufacturer "B" in May, 1915. As we know that between March and August, 1915, manufacturer "B" had been sending out shaving brushes, some of which were infected with Anthrax, it is clear that the brush implicated was one made by firm "B" from infected Chinese hair prior to the investigations made after the occurrence of Cases 1 and 2.

It is to be noted that the brushes had been in stock at the Eastbourne shop for at least fifteen months. Fortunately in this case there was no possibility of doubt as to the particular consignment implicated since the retailer had only received the one batch of brushes of this particular pattern.

Case 18.—A boy of fifteen died on 25th October, 1916, at Thornhill, Dumfries, with symptoms of acute meningitis. Cerebrospinal fluid removed by lumbar puncture was found by Dr. Ritchie to contain Anthrax bacilli.

Dr. Bryson, of Thornhill, has kindly informed me that the patient had a small scab below the angle of the jaw. Dr. Ritchie failed to find any trace of infection in this, but it was noted that the glands on that side of the neck were enlarged. The enlargement, however, was suggestive rather of early tubercular infiltration than of acute infection. The lad had begun shaving about a fortnight before his death and had bought a shaving brush. This brush was examined by Dr. Ritchie with negative results.

The history of this case raises the question whether the infection could possibly have been conveyed from a shaving brush or by a cut during shaving, with the production of Anthrax septicæmia without a local lesion at the site of entry. The case also recalls military case No. 16, in which no clue could be found to the origin of the disease. No local lesion was discovered in that case and the patient was thought to have died of cerebrospinal meningitis. In that case also, as in the Thornhill case, the diagnosis was made by bacteriological examination of cerebro-spinal fluid obtained by lumbar puncture.

Case 19.—A boiler maker suffering from malignant pustule was landed at Halifax, Nova Scotia, on October 24th, 1916, from a steamer from Liverpool, and he died there on October 30th. The surgeon on board the vessel suspected shaving brush infection and, on his return to Liverpool (November 11th), he made enquiries. It was found that the wife of the deceased had presented him with a shaving set, which included an imitation badgerhair brush in a metal handle. The brush was examined

by Professor Beattie, of Liverpool, and found to be infected with Anthrax, as was also a similar brush from a similar shaving set. Companion brushes examined by Dr. Eastwood were found to give in one instance a negative and in another a positive result. The brush came from a New York firm "Y", and was presumably made in the United States.

Following on our correspondence with regard to civil case No. 15, Dr. Hope, of Liverpool, had bacteriological examinations made of shaving brushes purchased more or less at random in Liverpool shops, and he kindly sent samples of the brushes for Dr. Eastwood to examine. Of nine different patterns of brush received, eight were imitation badgerhair brushes and one was made of hog's bristles. Anthrax bacilli were found in four of the different patterns. All of these were traced ultimately to manufacturer "B.". One was of pattern X, that is, the same pattern as was implicated in civil case No. 17, two were of pattern I, similar to those in civil cases 1 and 2, and one was of pattern IV, which was concerned with the civil cases Nos. 5 and 7. The brush of pattern X was probably manufactured prior to August, 1915, but the information with regard to the brushes of pattern I indicated that there were of more recent manufacture. This suggested failure of the arrangements made by firm "B" for disinfection of the hair. Dr. Collis re-visited the premises and found that the hair used for these brushes had been purchased accompanied by a certificate of steam disinfection, but he was not satisfied with the precautions taken at the works where the disinfection was alleged to have been carried out. No proper records were available to identify which particular batch of hair was disinfected.

This series of examinations made at Liverpool is interesting since they indicate that potentially dangerous shaving brushes still remain in the hands of retail dealers. It will not be surprising, therefore, if further cases occur from time to time.

Military cases.

Through the kindness of Colonel Barrow, of the Army Medical Department, I received a list of cases of Anthrax which had occurred in soldiers in England prior to August, 1915 (see cases 1 to 10 in Table II. Some inquiries were made by the Board's medical inspectors into these cases, but it was found very difficult to obtain information bearing on the possibility of shaving brush infection, although in several of the cases the site of the lesion suggested this origin in the absence of any other suspicious cause. Other cases among the Home Forces have come to my knowledge since August, 1915. These are included in Table II.

Colonel Beveridge has been good enough to supply a list of 28 cases of Anthrax which occurred among the troops in France from the beginning of 1915, to February, 1917. Of the 1915 cases 4 occurred in March, 1 in April, 1 in July, 3 in August, 1 in September, 5 in October, and 3 in November. In 1916 1 case occurred in February, 1 in March, 2 in April, 2 in May, 1 in July, 1 in August, and 1 in December. There was 1 case

in January, 1917. The following table shows the position of the lesion in these 28 cases:—

Right side of face	3	Side of neck	1
Left side of face	2	Side of neck below jaw ...	3
Face	2	Right submaxillary region	1
Right cheek ...	2	Left submaxillary region	2
Side of face ...	1	Submaxillary region ...	1
Right jaw ...	1	Left temple	1
Left side of chin	1	Sub-occipital region ...	1
Right side of neck	1	Right forearm	1
Left side of neck	2	Unknown	2

Total 28.

In a number of these cases the patients' shaving brushes were examined for Anthrax spores, but in every instance with negative results.

The possibility of infection from other sources than shaving brushes must, therefore, be admitted. Amongst these may be mentioned contact with horses, infected stables, infected ground, and blankets. But the striking preponderance in the above table of sites in the shaving area suggests some connection with shaving. It is known, also, that some of the consignments of infected shaving brushes were distributed to troops. Therefore, the failure to find Anthrax bacilli in the brushes used by the sufferers does not, in the absence of proof of another mode of infection, negative entirely the possibility that some of these cases were due to infected shaving brushes.

From officials at the Army Clothing Department I obtained the information that it was the practice to supply each soldier on joining with a new shaving brush. When the brush is worn out the soldier can buy another from the Army stores or from ordinary retailers. Usually the Army stores can sell them more cheaply than retailers, so that there is no inducement for the soldier to purchase elsewhere. Owing to the pressure caused by the war, it had been impracticable to insist on all shaving brushes complying strictly with the requirements of the Contracts Department; but practically all brushes accepted by the Army Contracts Department were made with pigs' bristles, and not with horsehair, which was known to be a dangerous material.

In the early stages of the war, however, local military authorities had provided for the stores shaving brushes purchased locally, and some of these were certainly of the imitation badger-hair type made from Chinese horsehair.

Dr. Seymour ascertained that at Reading a local military association had obtained a large number of shaving brushes from a local firm, who had been supplied by firm "A" with over 700 of the infected shaving brushes of the pattern concerned with civil cases Nos. 1 and 2. Military case No. 8 occurred in a sapper stationed for a time at Reading, who may have been supplied with one of these brushes.

In many instances it was not practicable to obtain evidence of the source of supply of shaving brushes to the military cases, but in view of the facts detailed above as to the use of cheap Chinese hair for making shaving brushes and as to the distribution in various parts of the country of infected brushes, the possibility that some of the military cases were due to shaving brush infection cannot be ignored, particularly in view of the striking preponderance of lesions in the shaving area. Cases 11, 12, 17 and 18 in Table II can be safely regarded as due to shaving brushes, and the information obtained in investigating cases 11 and 12, indicates another source of shaving brush infection which may possibly account for some of the military cases occurring subsequent to March, 1915.

On November 21st, 1915, a sapper died in the military hospital, Rochester, from Anthrax, the initial lesion being under the chin (military case 11). On the following day another sapper died in the same hospital with an anthrax lesion under the chin (case 12). Dr. Collis and I visited Chatham early in December to inquire further into these cases. Unfortunately the effects of the deceased men had been destroyed, so that their shaving brushes could not be obtained and it could not even be definitely ascertained what pattern of brush had been served out to them. We discovered, however, that two patterns of shaving brush had been issued from the stores department at Chatham, one composed of black hog's bristles and one an imitation badger-hair brush evidently composed partly or wholly of horsehair set in a wooden handle. Samples of both patterns were examined by Dr. Eastwood. The hog's bristle brushes were found free from Anthrax, but the horsehair brushes contained Anthrax spores. As the two patterns of brush had been mixed together in the pigeon holes at the stores an unopened box of the horsehair brushes was obtained and Dr. Eastwood found Anthrax spores in these also. The brushes were packed in sets of 10 in white cardboard boxes, and from the label outside it was found that the brushes had come from Canada.

Inquiry at the Army Clothing Department revealed the fact that these brushes were part of a consignment ordered on behalf of the Government in the winter of 1914. About 200,000 had been sent from Canada at various dates since February, 1915, and had been issued to various Army depots.

From inquiries made through the Colonial Office it was found that the firm in Canada from whom the brushes were bought had obtained them from manufacturers in New York. These manufacturers stated that the brushes were made from Chinese hair which was *supposed* to have been thoroughly disinfected. The outside hair was a mixture of white Chinese mane hair and "goat" hair dyed imitation badger, and the American firm claimed that as the hair had been made scalding hot in the process of dyeing, it must have been thoroughly disinfected, and they suggested that infection must have got on to the brushes by mixing with other stores.

The Board are in correspondence through the Foreign Office with the United States Government on the matter.

Military case No. 17.—A Canadian officer died at Bramshott, on January 4th, 1917, after an illness lasting 24 hours. The symptoms resembled those of cerebro-spinal fever. Death was found to be due to Anthrax. There was a razor cut on the face. The deceased had purchased a shaving brush some three week's previously at a local store. The brushes came from a firm in Aldershot, to whom they were sent on December 14th, 1914, by wholesaler "H". The brushes were made by manufacturer "B". The information I obtained, on inquiry at the wholesale dealers, indicated that these brushes were probably made from some of the same Chinese horsehair as was implicated in civil cases Nos. 1 and 2.

Anthrax spores were found in the original brush, and also in similar brushes from the same source. One of these brushes was examined by Dr. Eastwood and found to contain Anthrax spores.

This case recalls the Thornhill case (No. 18 on Table I), in which there was a small scab in the shaving area but no malignant pustule, whilst the symptoms suggested cerebro-spinal fever. In the Thornhill case, however, Anthrax bacilli were not found in the patient's shaving brush and the source of infection was, therefore, not clearly traced, whilst in this case the connection of the disease with shaving brush infection was clearly evident. My colleague, Surgeon-Col. Reece,* has published an account of these and other cases of Anthrax resembling cerebro-spinal fever. The series of cases suggests that in some instances Anthrax bacilli may enter the body by a cut, as in shaving, and cause Anthrax septicæmia simulating cerebro-spinal fever with no local lesion, or only a small local lesion at the site of inoculation.

Military case No. 18 also occurred at Bramshott. A private in a Canadian Regiment died on March 1st, 1917, from Anthrax. He had a pustule on the left cheek in the shaving area, and was supposed to have been infected from a shaving brush about the 25th February. The brush was an imitation badgerhair brush set in a black lacquered wooden handle and was issued regimentally. Through the courtesy of the Officer in Command of the Laboratory at the Bramshott Military Hospital the original brush used by the patient, and a companion brush of the same pattern and from the same issue were sent up for examination by Dr. Eastwood. He found both brushes to be heavily infected with Anthrax bacilli.

Conclusions.

I am not aware that, prior to the cases recorded by Dr. Elworthy, Anthrax infection by shaving brushes had been reported.

The danger of using Chinese, Siberian or Russian horsehair

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* *Lancet*, 1917, I, 406.

was, of course, well known, as was also the fact that brushmakers handling such hair were liable to Anthrax.*

Information obtained during the course of this inquiry suggests that British makers of shaving brushes avoided, before the War, the use of Chinese horsehair or took careful precautions as to disinfection. It was intimated that much of the Chinese, Siberian and Russian horsehair went to Germany, and that many of the cheap shaving brushes came from Germany before the War.

Germany had stringent regulations for the disinfection of all hair coming from foreign countries†.

On the outbreak of War there was simultaneously a great demand for cheap shaving brushes, partly to meet the requirements of the troops, and a cutting off of the German supply. This led (1) to manufacturers starting to make shaving brushes who had done little of this work before, and who knew little of the dangers of horsehair, and (2) to a demand for horsehair which overcame any reluctance British manufacturers may have had to the use of Chinese horsehair.

The history of the brushes responsible for the first two cases in the table of civil cases illustrates the dangers in misdescription. The first consignment of Chinese hair purchased by firm "A" after the War began was invoiced as "goats' hair" and was passed on to the manufacturer as goats' hair. Although subsequent parcels were invoiced by the broker "C" as goat and horse hair, the manufacturer was not informed that the hair was a mixture. Had he known that these parcels contained horsehair he would probably have taken steps to have the hair disinfected as he was aware of the Home Office requirements as to Chinese horsehair.

The evidence from large dealers in hair was that the cheap Chinese hair coming in short lengths was apt to be dirty and to contain mixed hair of various animals (sometimes even including human hair).

One of these brokers showed me samples of genuine goathair‡ which differed considerably in appearance from the mixture of cheap hair referred to above. Genuine goathair, I was told, was formerly used occasionally for brushmaking, but the quantity of real goathair available is too small to render it any considerable item in the manufacture of shaving brushes.

If this information is correct it would suggest that in the following figures from the Board of Trade returns horsehair or a mixture of horsehair and other hair, including goathair, may possibly figure under the heading "Goats', other than Mohair," as in each of the three years this material exceeds horsehair in quantity.

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* See reports by Dr. Legge in the Annual Reports of the Chief Inspector of Factories and Workshops for 1899, p. 323; 1902, p. 278. Also Dr. Legge's Milroy Lectures on Industrial Anthrax—*Lancet*, 1905. I, 695, 845.

† See Annual Reports of Chief Inspector of Factories and Workshops, 1899, p. 323; 1906, p. 313.

‡ *i.e.*, hair from beard and tail of goat.

Total imports of hair of various kinds during the years 1912, 1913, and 1914:—

Kind.	1912.		1913.		1914.	
	Quantity cwts.	Value £	Quantity cwts.	Value £	Quantity cwts.	Value £
Cow, ox, bull or elk	69,585	88,531	46,215	65,766	56,951	83,848
Goats', other than mohair	53,435	143,479	63,533	176,899	45,944	119,388
Horse	37,782	389,706	31,273	314,871	29,886	274,886
Unenumerated ...	—	494,214	—	432,260	—	375,030

I was informed that in the brokers' catalogues hair appeared under various descriptions, *e.g.*, "Long mane hair, black," "Long tails," etc., the approximate length being stated. Another class would appear as "Selected short tail, mixed, coloured." The trade buyers would know quite well that this description would cover a mixture of horsehair with other hair, including goathair. A still lower quality was known as "China combings," consisting of the refuse from the floors of the premises where the hair is sorted into lengths. It is usually very dirty material and recognised by the trade as being exceedingly liable to be infected with Anthrax. The Chinese hair is imported in cases or bales in which are closely packed a number of bundles or "drafts." These drafts consist of a large number of hairs of approximately the same length tied up tightly in bundles which may vary in thickness. The hair bundles are of different lengths, the longer hair being the more valuable. Some bundles may contain hairs only 2½ to 3 inches long, and it is such short hair that is used for making of shaving brushes. The bundles are tied with several bands of string.

Not infrequently pigs' bristles are mixed with the softer horsehair in the making of shaving brushes, and a considerable number of shaving brushes are made from hogs' bristles mainly or entirely. On various occasions hogs' bristles or brushes made from hogs' bristles have been examined for Anthrax with negative results, although I believe a considerable amount of this material comes from Siberia. It would appear that either hogs are less liable to Anthrax or the processes applied in dressing pigs' bristles before making them into brushes results in removal of infection.

Disinfection of hair containing Anthrax spores is not altogether a simple matter, as may be gathered from various experiments made under the auspices of the Home Office,* and there is some reason to think that some of the cases recorded above arose from hair which had been submitted to a process of disinfection in which complete destruction of the Anthrax spores had not be obtained.

Dr. Eastwood has made some experimental research into this matter, and is still pursuing his investigations. Meanwhile, it is clear that for steam disinfection to be successful, the cases or

* See Annual Reports of Factories and Workshops, 1899, p. 323; 1902, pp. 267, 278; 1904, p. 328, etc.; *Lancet*, 1905, I, 845.

bales should be opened, the bundles removed and most of the strings cut, unless the temperature inside the steam disinfecting apparatus is maintained at 230 F. for half-an-hour. The bundles should not be piled in too many layers, and certain other precautions are desirable.

A further point which appears is the long period during which Anthrax spores may remain dormant and yet develop in full virulence on conditions becoming favourable. I was informed that one consignment which led to infection in August, 1915, had been stored in London since 1912. On the other hand it is interesting to observe what a comparatively small proportion of infected shaving brushes caused Anthrax, although one would have thought that the action of shaving was exceedingly liable to lodge any organisms contaminating the brush in the skin of the user. Apparently a definite cutting or abrasion of the skin was necessary in many cases to allow the implantation of the germ. Further, it is noticeable that the infection usually occurred with a brush that had been used once only or very few times. It would seem that the constant dipping in hot water, the detergent action of the soap and the washing of the brush after using, rapidly washed away the infecting germs and thus rendered the brush harmless.

Considerable difficulties have attended the investigation of many of the cases here recorded, and it is certain that in many instances all the essential facts have not been obtained.

Frequently a considerable interval of time elapsed before information of the case reached the Board, and in many cases it was not practicable to get first-hand information on vital points. Frequently the suspected shaving brush had been destroyed and was not available for examination.

The complexities of trading arrangements often made it extraordinarily difficult to trace goods accurately. In some cases the number of hands through which the goods passed between the manufacturer and the customer was surprising. Both in warehouses of wholesale dealers and in the shops of retailers the arrangements for storage, etc., were not such as to enable a particular article to be identified with a particular consignment, and when several firms were involved, the possibilities of error and confusion were great.

I wish cordially to thank medical officers of health in many towns for the trouble they have taken in supplying information and in following up the cases. Doubtless the prompt action they have taken in obtaining the withdrawal from sale and the destruction of infected shaving brushes has tended to minimise the danger from this source. I must also express my thanks to the various firms concerned who invariably gave every facility for investigation and appeared to be genuinely anxious to take all possible steps to avoid danger to the public from the goods they had been selling. I am much indebted also for advice and assistance from Drs. Legge and Collis of the Home Office.

Administrative recommendations are not made in this report. Such action as appears to be indicated by the facts contained in the present report is under consideration by the Board.

April, 1917. FRANCIS J. H. COUTTS.

Table I.

Civil Cases.

Identification No.	Town.	Age.	Occupation.	Site of lesion.	Result D-Death. R-Recovery.	Approximate date. Onset.	Coming under observation.	Death.	Shaving brush. Approximate date of purchase.	Pattern.	Bacteriological examination. Original brush.	Others from same source.	Bacteriologist.	Source of brush. Retailer.	Wholesale dealer.	Manufacturer.	Remarks.
1	London ...	32	Solicitor's clerk	Neck ...	D	June 29, 1915	July 1, 1915 ...	July 2, 1915 ...	June 15, 1915	I.	+	+ +	Elworthy ... Eastwood	N. Kensington	A	B	
2	Deptford ...	52	Hawker... ...	Face ...	R	June 27, 1915	July 13, 1915	—	June 20, 1915	I.	+	+	Elworthy ... Eastwood	Deptford ...	A	B	
3	Bristol ...	20	Burner man. copper ore furnace	Back of neck	R	July 22,	1915	—	June, 1915 ...	II.	+	...	Elworthy ... Eastwood	Bristol ...	—	F	Hair from premises of manufacturer F found infected with Anthrax.
4	Southall ...	—	Working a stationary engine	Cheek ...	R	June 16, 1915	June 17, 1915	—	June, 1915 ...	III.	...	+	Eastwood ...	Southall Green	G	B	
5	Coventry ...	34	Woodworker ...	Angle lower jaw	D	Dec. 3, 1915 ...	Dec. 6, 1915 ...	Dec. 7, 1915 ...	Nov. 25, 1915	IV.	+	+	Eastwood ...	Coventry ...	H	B	
6	Portsmouth ...	—	— ...	Neck ...	D	—	—	Dec. 31, 1915	?	?		—	Eastwood ...	—	—	—	
7	Torquay ...	34	Gasworker ...	Shaving area, right side	R	Jan. 22, 1916	Jan. 24, 1916	—	Jan. 8, 1916 ...	IV.	+	... +	Thompson Eastwood ...	Bath ...	H	B	
8	Glasgow ...	—	— ...	Neck ...	D	Mar. 11, 1916	Mar. 13, 1916	Mar. 15, 1916	Mar. 7, 1916...	V.	+	+	Glasgow bacteriologist	Glasgow ...	J	K	Hair supposed to have been disinfected.
9	Folkestone ...	—	Greaser (railway)	Cheek ...	R	Mar. 16, 1916	Mar. 18, 1916	—	Mar. 10, 1916	VI.	+	+	Eastwood ...	Folkestone	M	B	
10	Sheffield ...	—	Meter inspector	—	D	—	—	Mar. 14, 1916	—	—	...	...	—	—	—	—	See Notes on Case 12
11	Birmingham...	—	Engineer ...	Neck ...	R	May 2,	1916	—	—	VII.	+	... +	Leith ... Eastwood ...	Birmingham	N	B	
12	Glasgow ...	—	— ...	Cheek ...	—	—	Aug., 1916 ...	—	—	?	...	+	Glasgow bacteriologist	—	—	O	
13	Sheffield ...	20	— ...	Chin ...	R	Aug. 3, 1916	Aug. 6, 1916 ...	—	Before Aug. 2, 1916	VIII.	... ...	+ +	Eastwood ... Delépine Newcastle bacteriologist	R. Sheffield	S	Japanese	
14	Leslie (Fife)...	36	Electrician ...	Face ...	D	August,	1916	Sept. 1, 1916...	Aug. 26, 1916	?	...	...	—	Glasgow ...	—	—	Brush destroyed ; information as to origin unobtainable.
15	Mossley ...	—	Clergyman ...	Chin ...	D	Sept. 21,	1916	Sept. 30, 1916	Sept. 14, 1916	IX.	...	+	Eastwood ...	Blackpool T.	V	W New York	
16	Halifax ...	—	Silk manufacturer	Right side neck	R	Before Sept.	19, 1916 ...	—	Aug. 28, 1916	IV.	+	... +	Eurich ... Eastwood ...	London ...	H	B	
17	Guildford R....	64	Labourer. Gunpowder works	Left cheek	D	Oct. 23, 1916	Oct. 29, 1916	Oct. 30, 1916	Oct. 7, 1916 ...	X	+	+	Eastwood ...	Eastbourne	X	B	Bone handle ; imitation badger hair brush.
18	Thornhill ...	15	?	Small scab angle of jaw	D	?	?	Oct. 25, 1916	About Oct. 10, 1916	—	(--)	...	Ritchie ...	—	?	—	Anthrax bacilli found in cerebro-spinal fluid removed by lumbar puncture P.M.
19	Liverpool ...	—	Boiler maker ...	—	D	Oct. 24,	1916	Oct. 30, 1916	?	XI	+	+ +	Beattie ... Eastwood ...	Liverpool ...	—	Y New York	

Table II.

Military cases of Anthrax.

No.	Place.	Site of lesion.	Approximate date.	Result.	Shaving brush suspected.	Remarks.
1	Aldershot	—	5th Dec., 1914 ...	—	Yes	Materials from barber's shop examined; found free from Anthrax.
2	Aldershot	Neck	21st Dec., 1914 ...	R	?	
3	Aldershot	Right shoulder ...	3rd Jan., 1915 ...	D	?	? Infection from cattle.
4	Tunbridge Wells...	Left cheek ...	Before 13th March, 1915	D	?	Blankets suspected at the time.
5	Preston	?	27th March, 1915	?	?	No information obtainable.
6	Aldershot	Left side neck ...	9th June, 1915 ...	D	?	
7	Shorncliffe ...	Cheek	9th June, 1915 ...	R	?	
8	Reading	Left zygoma ...	1st July, 1915 ...	R	?	Infected brushes known to have been distributed to soldiers in this district.
9	Torquay	?	11th July, 1915 ...	?	?	
10	Liverpool	Neck, beneath chin	15th July, 1915 ..	D	?	Possible infection from handling hides.
11	Chatham	Under chin ...	21st Nov., 1915 ...	D	Yes	Probable infection from shaving brushes imported from Canada.
12	Chatham	Under chin ...	22nd Nov., 1915 ...	D	Yes	
13	Farnham	Angle of jaw ...	9th Dec., 1915 ...	D	Yes	Patient's shaving brush could not be obtained.
14	Aldershot	Cheek	31st Dec., 1915 ...	D	Yes	Shaving brush destroyed.
15	Aldershot	Left side face ...	8th Feb., 1916 ...	R	Yes	
16	London	Generalised ...	25th May, 1916 ...	D	No	Internal Anthrax. No external lesion found. Shaving brush unobtainable.
17	Bramshott ...	Generalised ...	Jan., 1917 ...	D	Yes	Anthrax bacilli found in original brush and similar brushes.
18	Bramshott ...	Left cheek ...	Feb., 1917 ...	D	Yes	Anthrax bacilli found in original brush and similar brushes.

FOR OFFICIAL USE.

REPORTS

TO THE

LOCAL GOVERNMENT BOARD

ON

PUBLIC HEALTH AND MEDICAL SUBJECTS.

(NEW SERIES No. 113.)

STATISTICS

OF THE

INCIDENCE OF

NOTIFIABLE INFECTIOUS DISEASES

IN EACH SANITARY DISTRICT IN ENGLAND AND WALES DURING THE YEAR 1916 (SIXTH YEAR).

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STATISTICS

OF THE

Incidence of Notifiable Infectious Diseases in each Sanitary District in England and Wales during the year 1916.

To the Right Honourable Lord Rhondda,
President of the Local Government Board.

My Lord,

I have the honour to submit the following statistics of cases of notifiable infectious diseases reported during the year 1916. The statement comprises the number of cases and the incidence in relation to population of each of the notifiable acute infectious diseases in every sanitary area of England and Wales and in certain grouped areas. This statement is the sixth complete annual record of the kind. The series of statistics of infectious diseases to which it belongs was rendered practicable by the Board's General Order of 13th December, 1910, which made it the duty of Medical Officers of Health of extra-metropolitan sanitary areas to transmit to the Board each Monday a statement of the number of cases of infectious disease notified to them during the preceding week. A weekly summary of these returns, giving the cases notified in every sanitary area, is sent out by the Board on the Thursday of the week following that to which the summary relates, to every medical officer of health. The statement of the number of cases of infectious diseases notified during the year 1916 in each district in England and Wales, which is given in the following pages, is based on these weekly returns.*

* Similar information is given for the Metropolis, returns for which are sent to the Board weekly by the Metropolitan Asylum Managers. These returns are compiled from copies of notifications received by the Managers from Metropolitan Medical Officers of Health under Sec. 55 (4) of the Public Health (London) Act, 1891. The weekly returns from ports are made in pursuance of the duty imposed on the Port Medical Officers of Health, except in the case of London, by the Board's General Order. The returns for pulmonary tuberculosis in London are derived from information supplied by Dr. Hamer.

(11131—29.) Wt. 2580—813. 2000. 6/17. D & S. G. 20/ 40.

Description of the Tables.—The statistics are tabulated in order of counties given alphabetically.

The statistics for administrative counties as a whole are shown in the summary table on pp. 12-15, and for county boroughs on pp. 16-17.

The statistics for each county contain information as to the incidence of the chief acute infectious diseases in—

1. The entire administrative county.
2. Each county borough within the geographical county.
3. The aggregate of the boroughs and urban districts situate within the administrative county.
4. The aggregate of the rural districts situate within the administrative county.
5. Each single borough and urban district.
6. Each single rural district.

In the tables the number of cases and the rate per 1,000 of population are given for each of the following diseases:—

Small-pox.
Scarlet Fever.
Diphtheria.
Enteric Fever.
Puerperal Fever.
Erysipelas.

Cases of typhus fever are shown in footnotes to the county tables.

No cases of cholera occurred during 1916.

There were 12 cases of plague, 6 of which occurred at Liverpool, 4 at Bristol and 2 at Hull.

As already stated, case-rates are given for each sanitary area in England and Wales. Many of these districts have very small populations, and in many instances the rate is calculated on one or only a few cases of disease. In this respect the practice of the Registrar-General has been followed. **Although for convenience of reference such rates have been given, it is evident that in judging of their significance reference should always be made to the population and to the number of cases of sickness on which each rate is based.**

It is unnecessary to labour the point that the epidemiological and administrative value of the rates set out in the tables in this return steadily increases as it becomes possible to compare a longer series of years.

Cases of Sickness among Sailors and Soldiers.—Section 5 (*b*) of the Local Government (Emergency Provisions) Act, 1916, provides that the Medical Officer of Health of a local authority shall receive notifications of all cases of infectious diseases arising in barracks, camps, &c., in the occupation of His Majesty's forces. The Act came into force on the 17th May, 1916. Before this date the duty of notifying cases of infectious diseases to the Medical Officer of Health did not apply in respect of persons living in any building, &c., belonging to the Crown. In connection with the further increase in the naval and military population during 1915 and with the concentration of troops in special

localities, many notifications of military and naval cases were sent to Medical Officers of Health in 1915; but in view of the irregular extent to which this occurred, and of the disturbing effect on local statistics, it was decided, as in 1914, not to include these notifications in the returns for each sanitary area in the annual return for 1915. They were, however, stated separately in Table I. for England and Wales as a whole. The same plan has been adopted for 1916. The naval and military notifications received by Medical Officers of Health during 1916, both before and after the Local Government (Emergency Provisions) Act came into operation, have been stated separately at the end of Table I.

Sickness Statistics for 1916.—During 1916, the total number of cases of the chief notifiable diseases in England and Wales, including cases in ports but excluding cases among sailors and soldiers, was as follows:—

Disease.	England and Wales, 1916.	
	No. of cases notified.	Rate per 1,000 of population.
Tuberculosis, (pulmonary)	72,479	2·10
„ (other forms)	23,777	0·69
Small-pox	149	0·00
Typhus Fever	4	0·00
Scarlet Fever	75,722	2·19
Diphtheria	51,707	1·50
Enteric Fever	5,564	0·16
Continued Fever	82	0·00
Relapsing Fever	—	—
Puerperal Fever	1,996	0·06
Erysipelas	18,510	0·54
Cerebro-Spinal Fever...	1,306	0·04
Poliomyelitis	689	0·02
Cholera...	—	—
Plague	12	0·00
Ophthalmia Neonatorum	7,613	9·69*
Measles and German Measles	348,090	10·09

* Rate per 1,000 births.

Of the above, the following cases, being chiefly cases of imported disease, were notified to port sanitary authorities:—

Small-pox, 14; Scarlet Fever, 39; Diphtheria, 33; Enteric Fever, 126; Erysipelas, 28; Continued Fever, 3; Pulmonary Tuberculosis, 185; Tuberculosis (other forms), 41; Puerperal Fever, 3; Cerebro-Spinal Fever, 1; Poliomyelitis, 1; Ophthalmia Neonatorum, 2; Measles and German Measles, 236.

Seasonal Incidence.—The following table shows the seasonal incidence of scarlet fever, diphtheria, enteric fever, cerebro-spinal fever, and poliomyelitis during 1916. The actual average weekly number of cases is given at the base of each column. The proportion of the notifications to this average taken as 100 is shown for each week, any special seasonal excess of 30 per cent. over the mean for the whole year being shown by black type.

ENGLAND AND WALES.

Week ending (1916).	Scarlet Fever.	Diphtheria.	Enteric Fever.	Cerebro-Spinal Fever.	Poliomyelitis.	Measles and German Measles.
Jan. 8	148	101	119	132	54	159
" 15	143	112	111	100	62	116
" 22	149	131	111	64	85	95
" 29	142	144	121	160	54	104
Feb. 5	139	148	100	152	54	104
" 12	120	141	76	132	54	115
" 19	136	134	80	124	23	126
" 26	118	113	85	140	54	128
March 4	120	112	93	152	31	126
" 11	114	100	69	104	39	136
" 18	113	106	76	124	16	134
" 25	122	105	82	216	54	156
April 1	119	107	66	236	39	167
" 8	119	105	86	220	16	178
" 15	117	111	96	244	31	190
" 22	96	86	85	228	16	172
" 29	107	91	92	200	31	189
May 6	97	91	80	128	23	208
" 13	104	88	81	176	39	166
" 20	101	96	86	136	39	163
" 27	100	101	81	148	31	167
June 3	95	97	84	88	16	157
" 10	96	90	68	92	16	124
" 17	91	79	72	112	16	120
" 24	91	83	87	92	31	126
July 1	98	85	97	68	62	126
" 8	93	85	90	116	46	124
" 15	89	84	76	80	23	110
" 22	89	90	77	36	108	105
" 29	91	87	81	56	62	93
Aug. 5	75	77	81	72	93	80
" 12	69	82	99	52	93	61
" 19	65	74	86	44	254	47
" 26	70	75	99	64	293	37
Sept. 2	76	74	108	60	300	33
" 9	79	79	129	48	339	26
" 16	86	96	120	60	239	27
" 23	83	98	165	56	346	26
" 30	99	102	230	52	277	28
Oct. 7	93	103	231	56	239	32
" 14	93	105	169	80	216	37
" 21	94	98	132	40	316	35
" 28	102	111	129	64	231	36
Nov. 4	101	102	139	44	146	40
" 11	99	108	95	48	154	49
" 18	93	108	107	52	185	47
" 25	96	105	119	60	123	57
Dec. 2	87	108	76	56	93	60
" 9	82	100	78	48	100	61
" 16	74	98	82	88	39	69
" 23	67	75	68	72	54	65
" 30	58	72	55	88	23	67
	100	100	100	100	100	100
Average weekly number of cases notified.	1,456	994	107	25	13	6,694

Sickness Rates per 1,000 of Population.

Disease.	Year.	England and Wales (including Ports).	England.	Wales (including Monmouth).	London.	Aggregate of Administrative Counties of—		Aggregate of County Boroughs of—		Aggregate of Non-County Boroughs and Urban Districts of—		Aggregate of Rural Districts of—	
						England (excluding London).	Wales (including Monmouth).	England.	Wales (including Monmouth).	England (excluding London).	Wales (including Monmouth).	England.	Wales (including Monmouth).
Small-pox	1911	0·01	0·01	0·00	0·02	0·01	0·00	0·01	—	0·01	0·00	0·00	0·00
	1912	0·00	0·00	0·00	0·00	0·00	0·00	0·01	—	0·00	—	0·00	0·00
	1913	0·00	0·00	0·00	0·00	0·00	—	0·00	0·02	0·00	—	0·00	—
	1914	0·00	0·00	0·00	0·00	0·00	—	0·00	0·01	0·00	—	0·00	—
	1915	0·00	0·00	—	0·00	0·00	—	0·00	—	0·00	—	—	—
	1916	0·00	0·00	0·03	0·00	0·00	0·01	0·00	0·12	0·00	0·01	0·00	0·00
Scarlet Fever	1911	2·90	2·84	3·66	2·33	2·71	3·62	3·32	3·85	2·91	4·43	2·37	2·49
	1912	2·98	2·95	3·35	2·51	2·77	3·32	3·46	3·46	2·95	3·88	2·47	2·52
	1913	3·58	3·51	4·52	3·89	2·96	4·40	4·26	5·05	3·18	5·23	2·61	3·20
	1914	4·47	4·38	5·40	5·54	3·87	5·28	4·74	5·90	4·12	6·07	3·45	4·13
	1915	3·59	3·53	4·39	3·94	3·32	4·66	3·71	3·17	3·43	5·36	3·14	3·66
	1916	2·19	2·14	2·89	2·07	2·12	3·02	2·21	2·31	2·21	3·51	1·96	2·32
Diphtheria	1911	1·33	1·33	1·30	1·64	1·22	1·21	1·47	1·68	1·22	1·11	1·09	1·36
	1912	1·24	1·24	1·27	1·57	1·10	1·13	1·32	1·84	1·17	1·13	1·00	1·13
	1913	1·39	1·39	1·40	1·70	1·26	1·30	1·48	1·86	1·41	1·39	1·03	1·16
	1914	1·61	1·60	1·53	2·02	1·53	1·42	1·54	2·02	1·66	1·54	1·32	1·24
	1915	1·52	1·52	1·43	2·11	1·40	1·38	1·49	1·64	1·49	1·43	1·25	1·30
	1916	1·50	1·51	1·35	2·06	1·41	1·32	1·45	1·46	1·53	1·34	1·20	1·30
Enteric Fever	1911	0·38	0·38	0·38	0·23	0·39	0·40	0·43	0·26	0·43	0·52	0·33	0·24
	1912	0·23	0·23	0·21	0·16	0·22	0·20	0·28	0·25	0·24	0·24	0·18	0·14
	1913	0·23	0·22	0·23	0·17	0·22	0·24	0·25	0·18	0·24	0·28	0·18	0·17
	1914	0·24	0·23	0·17	0·17	0·23	0·17	0·24	0·13	0·25	0·20	0·20	0·13
	1915	0·18	0·18	0·15	0·14	0·17	0·16	0·20	0·10	0·19	0·19	0·14	0·11
	1916	0·16	0·16	0·18	0·11	0·17	0·19	0·16	0·14	0·17	0·21	0·17	0·14

Sickness Rates per 1,000 *of Population*—cont.

Disease.	Year.	England and Wales (including Ports).	England.	Wales (including Monmouth).	London.	Aggregate of Administrative Counties of—		Aggregate of County Boroughs of—		Aggregate of Non-County Boroughs and Urban Districts of—		Aggregate of Rural Districts of—	
						England (excluding London).	Wales (including Monmouth).	England.	Wales (including Monmouth).	England (excluding London).	Wales (including Monmouth).	England.	Wales (including Monmouth).
Puerperal Fever	1911	0·06	0·06	0·06	0·07	0·04	0·06	0·08	0·04	0·05	0·07	0·03	0·05
	1912	0·06	0·06	0·07	0·08	0·05	0·07	0·07	0·06	0·05	0·09	0·04	0·04
	1913	0·05	0·05	0·05	0·08	0·04	0·05	0·07	0·05	0·04	0·05	0·03	0·04
	1914	0·06	0·06	0·07	0·09	0·05	0·07	0·08	0·07	0·05	0·08	0·04	0·06
	1915	0·06	0·06	0·07	0·06	0·04	0·07	0·08	0·07	0·05	0·08	0·04	0·06
	1916	0·06	0·06	0·07	0·07	0·04	0·05	0·08	0·15	0·05	0·06	0·04	0·05
Erysipelas	1911	0·69	0·71	0·44	1·09	0·56	0·44	0·81	0·47	0·62	0·53	0·46	0·31
	1912	0·63	0·65	0·46	0·91	0·53	0·45	0·75	0·54	0·56	0·51	0·45	0·36
	1913	0·63	0·64	0·46	0·92	0·52	0·46	0·74	0·50	0·58	0·52	0·43	0·37
	1914	0·73	0·74	0·58	1·10	0·59	0·57	0·84	0·64	0·66	0·67	0·47	0·43
	1915	0·66	0·67	0·53	0·89	0·56	0·52	0·76	0·60	0·62	0·58	0·46	0·43
	1916	0·54	0·54	0·42	0·67	0·48	0·40	0·59	0·48	0·52	0·46	0·42	0·32
Cerebro-Spinal Fever	1913	0·01	0·01	0·00	0·02	0·01	0·00	0·01	0·01	0·01	0·00	0·01	0·00
	1914	0·01	0·01	0·00	0·02	0·01	0·00	0·01	0·01	0·00	0·01	0·01	—
	1915	0·07	0·08	0·04	0·14	0·07	0·03	0·06	0·07	0·07	0·03	0·07	0·02
	1916	0·04	0·04	0·01	0·10	0·03	0·01	0·03	0·02	0·03	0·01	0·02	0·01
Poliomyelitis	1913	0·02	0·02	0·01	0·03	0·02	0·01	0·02	0·01	0·02	0·01	0·01	0·01
	1914	0·01	0·01	0·00	0·02	0·01	0·00	0·02	0·01	0·01	0·00	0·01	—
	1915	0·01	0·02	0·01	0·02	0·02	0·01	0·01	0·01	0·02	0·00	0·01	0·01
	1916	0·02	0·02	0·01	0·04	0·02	0·00	0·01	0·02	0·02	0·01	0·01	0·00

Small-pox.—In England and Wales, 149 cases of small-pox were notified, as compared with 90 in 1915, 65 in 1914, 115 in 1913, 123 in 1912, and 295 in 1911. These figures include some cases notified which subsequently proved not to be small-pox.

55 cases were notified from towns connected with ports, viz., 49 at Cardiff, 3 at Newport (Mon.), 2 at Barry, and 1 at Southampton.

14 cases, as compared with 12 in 1915, 7 in 1914, 25 in 1913, 12 in 1912, and 30 in 1911, were notified to port sanitary authorities, being chiefly imported cases. Of these, 7 occurred in Liverpool, 2 each in London and Hull, and 1 each in Bristol, Tees (River), and Tyne port sanitary districts.

Of the remaining 80 cases, 58 were notified in Lancashire (Hindley 23, Salford 8, Atherton 4, Whitefield 4, Abram 3, Mossley 3, Radcliffe 2, 1 case occurring in each of 11 other districts); 7 cases were notified in Penarth, 3 in Stalybridge, 4 in South Shields, and 1 in each of 7 other districts outside London. Only 1 case occurred in London (Fulham).

Typhus Fever.—Only 4 cases of typhus fever were notified, as compared with 45 in 1915, 15 in 1914, 18 in 1913, 31 in 1912, and 65 in 1911. These figures include some cases notified which subsequently proved not to be typhus. The cases were notified from 3 sanitary districts, viz., 2 in Liverpool and 1 each in Warrington and Milford Haven.

Scarlet Fever.—75,722 cases of scarlet fever were notified, as compared with 127,086 in 1915, 165,045 in 1914, 130,707 in 1913, 107,508 in 1912, and 104,651 in 1911.

Diphtheria.—51,707 cases of diphtheria were notified, as compared with 53,597 in 1915, 59,357 in 1914, 50,903 in 1913, 44,754 in 1912, and 47,802 in 1911.

Enteric Fever.—5,564 cases of enteric fever were notified, as compared with 6,364 in 1915, 8,778 in 1914, 8,263 in 1913, 8,386 in 1912, and 13,852 in 1911.

In 17 instances Paratyphoid was specifically notified.

Continued Fever.—In addition to the above cases of enteric fever, 82 cases of "Continued fever," not otherwise defined, were notified.

Puerperal Fever.—1,996 cases of puerperal fever were notified, as compared with 2,057 in 1915, 2,338 in 1914, 1,989 in 1913, 2,184 in 1912, and 2,029 in 1911.

Erysipelas.—18,510 cases of erysipelas were notified, as compared with 23,382 in 1915, 26,977 in 1914, 23,132 in 1913, 22,886 in 1912, and 24,950 in 1911.

Cerebro-Spinal Fever.—The total number of cases notified in England and Wales during the year 1916 was 1,306, as compared

with 2,566 in 1915, 315 in 1914, and 305 in 1913. The distribution of the cases is shown in the following table:—

—	London.	County Boroughs.	Boroughs and Urban Districts.	Rural Districts.	Port Sanitary Districts.	Total.
England	428	381	317	153	1	1,280
Wales (including Monmouth) ...	—	7	9	10	—	26
Total ...	428	388	326	163	1	1,306

Acute Poliomyelitis.—The total number of cases of poliomyelitis notified in England and Wales during 1916 was 689, as compared with 517 in 1915, 509 in 1914, and 729 in 1913. The distribution of the cases is shown in the following table:—

—	London.	County Boroughs.	Boroughs and Urban Districts.	Rural Districts.	Port Sanitary Districts.	Total.
England	190	160	233	89	1	673
Wales (including Monmouth) ...	—	9	6	1	—	16
Total ...	190	169	239	90	1	689

Measles.—By order dated 27 November, 1915, the Board made regulations requiring the notification of cases of measles and German measles to the Medical Officer of Health by medical practitioners and by parents and guardians or other persons in charge of the patient. The order came into force on the 1st January, 1916. The weekly statements of notified infectious disease from which this annual return is compiled do not distinguish between notified cases of measles and German measles, nor between notifications by medical practitioners and by parents and guardians. A detailed tabulation of the returns received has therefore not been made for each sanitary area. The total number of notifications of measles and German measles in England and Wales during 1916 was 348,090. The seasonal incidence is shown in the table on page 6. A separate return of notifications of measles and German measles has been obtained from the Medical Officers of Health of the Metropolitan boroughs and County boroughs giving more detailed information than is included in the statement received each week from Medical Officers of Health. A statement based on those more complete returns will be included in a special report on measles which is under preparation in the medical department.

Ophthalmia Neonatorum.—During 1916 7,613 cases of ophthalmia neonatorum were notified, as compared with 6,806 in 1915.

Tuberculosis.—The incidence of pulmonary and of other forms of tuberculosis since these diseases became compulsorily notifiable throughout England and Wales is shown in the following table.

For reasons given on pages xcix-ci of my Annual Report for 1913-14, it has not been considered advisable to give statistics for smaller areas than those enumerated in the table on the next page. This table gives the aggregate of the total notifications returned weekly to the Board by medical officers of health. It includes a considerable number of duplicate notifications, the number of these varying greatly in different areas. The number of such duplicate notifications is particularly large in London. The rates given below must be considered in the light of these facts.

—	Pulmonary Tuberculosis.									
	1912.		1913.		1914.		1915.		1916.	
	No. of cases notified.	Rate per 1000 of population.	No. of cases notified.	Rate per 1000 of population.	No. of cases notified.	Rate per 1000 of population.	No. of cases notified.	Rate per 1000 of population.	No. of cases notified.	Rate per 1000 of population.
London	33,392	7·39	22,655	5·01	16,459	3·64	14,717	3·41	13,544	3·19
England (excluding London)	72,193	2·44	68,446	2·32	59,552	1·99	54,510	1·90	54,643	1·96
Wales (including Monmouth) ...	4,966	2·01	5,432	2·19	4,851	1·92	4,127	1·70	4,107	1·74
Total (including cases notified in Port Sanitary Districts)	110,706	3·03	96,841	2·65	81,159	2·20	73,538	2·07	72,479	2·10

—	Other Tuberculosis.							
	1913 (11 months).		1914.		1915.		1916.	
	No. of cases notified.	Annual rate per 1000 of population.	No. of cases notified.	Rate per 1000 of population.	No of cases notified.	Rate per 1000 of population.	No. of cases notified.	Rate per 1000 of population.
London	6,428	1·55	3,861	0·85	3,948	0·92	4,083	0·96
England (excluding London) ...	30,050	1·11	19,396	0·65	17,761	0·62	18,432	0·66
Wales (including Monmouth) ..	1,712	0·75	1,087	0·43	1,108	0·46	1,221	0·52
Total (including cases notified in Port Sanitary Districts)	38,200	1·14	24,366	0·66	22,864	0·65	23,777	0·69

I am again indebted to Dr. Stevenson, of the General Register Office, for arranging for the calculation of the rates given in the following tables. The civil populations given in the first column of the following tables have been estimated in the General Register Office.

I am, my Lord,

Your obedient Servant,

ARTHUR NEWSHOLME,

Medical Officer.

April, 1916.

TABLE

Statistics of Infectious Diseases

—	Estimated Civil Population in the middle of 1916.	Scarlet Fever.		Diphtheria.		Enteric Fever.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
ENGLAND AND WALES* ...	34,500,000	75,722	2·19	51,707	1·50	5,564	0·16
ENGLAND	32,135,073	68,848	2·14	48,484	1·51	5,021	0·16
WALES (INCLUDING MONMOUTHSHIRE).	2,364,927	6,835	2·89	3,190	1·35	417	0·18
LONDON	4,237,387	8,762	2·07	8,741	2·06	457	0·11
ADMINISTRATIVE COUNTIES (ENGLAND AND WALES) EXCLUDING LONDON.	18,808,820	41,551	2·21	26,333	1·40	3,191	0·17
Bedfordshire	186,002	240	1·29	823	4·42	22	0·12
Berkshire	173,359	466	2·69	222	1·28	16	0·09
Buckinghamshire	206,697	461	2·23	306	1·48	15	0·07
Cambridgeshire	118,371	162	1·37	139	1·17	6	0·05
Isle of Ely	66,053	83	1·26	59	0·89	20	0·30
Cheshire	572,509	1,688	2·95	1,128	1·97	85	0·15
Cornwall	296,132	360	1·22	622	2·10	33	0·11
Cumberland	199,223	945	4·74	212	1·06	41	0·21
Derbyshire	539,588	1,489	2·76	992	1·84	70	0·13
10–Devonshire	387,187	471	1·22	546	1·41	70	0·18
Dorsetshire	201,393	319	1·58	155	0·77	27	0·13
Durham	836,711	2,768	3·31	1,378	1·65	531	0·63
Essex	836,507	1,584	1·89	1,508	1·80	91	0·11
Gloucestershire	300,513	494	1·64	304	1·01	39	0·13
Herefordshire	103,494	161	1·56	88	0·85	3	0·03
Hertfordshire	298,072	394	1·32	487	1·63	24	0·08
Huntingdonshire	51,095	78	1·53	20	0·39	3	0·06
Kent	964,254	1,803	1·87	1,583	1·64	204	0·21
Lancashire	1,620,062	5,101	3·15	1,527	0·94	395	0·24
20–Leicestershire	240,220	381	1·59	236	0·98	31	0·13
Lincolnshire—Holland ...	78,466	146	1·86	56	0·71	9	0·11
„ Kesteven ...	104,882	193	1·84	92	0·88	4	0·04
„ Lindsey ...	227,397	342	1·50	374	1·64	22	0·10
Middlesex	1,169,806	2,282	1·95	1,796	1·54	114	0·10
Norfolk	291,662	348	1·19	272	0·93	90	0·31
Northamptonshire	202,552	332	1·64	489	2·41	23	0·11
Soke of Peterborough ...	45,374	129	2·84	33	0·73	1	0·02
Northumberland	357,283	883	2·47	520	1·46	61	0·17
Nottinghamshire	344,501	690	2·00	562	1·63	63	0·18
30–Oxfordshire	121,227	197	1·63	89	0·73	6	0·05
Rutlandshire	17,433	10	0·57	15	0·86	—	—
Shropshire	226,503	378	1·67	331	1·46	7	0·03
Somersetshire	355,749	518	1·46	386	1·09	75	0·21
Southampton	384,129	538	1·40	382	0·99	53	0·14
Isle of Wight	76,925	138	1·79	201	2·61	5	0·06
Staffordshire	650,034	2,003	3·08	1,009	1·55	58	0·09
Suffolk—East	182,573	241	1·32	220	1·20	19	0·10
„ West	103,030	177	1·72	100	0·97	6	0·06
Surrey	647,078	990	1·53	695	1·07	55	0·08
40–Sussex—East	218,212	289	1·32	200	0·92	15	0·07
„ West	158,706	320	2·02	138	0·87	17	0·11
Warwickshire	299,693	659	2·20	324	1·08	20	0·07
Westmorland	58,201	68	1·17	23	0·40	8	0·14
Wiltshire	268,806	747	2·78	318	1·18	17	0·06
Worcestershire	271,442	449	1·65	414	1·53	9	0·03
Yorkshire—East Riding ...	145,189	210	1·45	86	0·59	19	0·13
„ North Riding...	276,291	334	1·21	280	1·01	61	0·22
„ West Riding ...	1,405,390	2,680	1·91	2,047	1·46	272	0·19
AGGREGATE OF ENGLISH ADMINISTRATIVE COUNTIES (EXCLUDING LONDON).	16,885,976	35,739	2·12	23,787	1·41	2,835	0·17

* Including

I.

in Administrative Counties.

Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.	Small-pox cases.	Typhus Fever cases.	Continued Fever cases.	Cerebro-spinal Fever cases.	Poliomyelitis cases.	Ophthalmia Neonatorum cases.	Pulmonary Tuberculosis cases.	Other Tuberculosis cases.
1,996	0·06	18,510	0·54	149	4	82	1,306	689	7,613	72,479	23,777
1,824	0·06	17,492	0·54	72	3	74	1,279	672	7,247	68,187	22,515
169	0·07	990	0·42	63	1	5	26	16	364	4,107	1,221
276	0·07	2,845	0·67	1	—	21	428	190	757	13,544	4,083
815	0·04	8,927	0·47	63	1	44	489	329	2,646	27,732	9,607
7	0·04	94	0·51	—	—	—	3	7	13	339	72
6	0·03	42	0·24	—	—	—	11	6	24	228	55
4	0·02	85	0·41	—	—	—	9	3	22	246	71
3	0·03	53	0·45	—	—	—	4	3	25	254	103
2	0·03	34	0·51	—	—	—	6	4	3	111	39
62	0·11	371	0·65	3	—	—	5	4	85	708	291
15	0·05	113	0·38	—	—	2	10	11	26	364	96
3	0·02	120	0·60	—	—	—	—	3	28	303	49
24	0·04	250	0·46	—	—	—	5	3	95	910	350
4	0·01	120	0·31	—	—	—	6	7	17	626	152–10
10	0·05	76	0·38	—	—	—	19	6	21	222	55
24	0·03	485	0·58	1	—	7	8	6	131	1,636	1,040
44	0·05	368	0·44	1	—	2	47	62	97	1,193	542
10	0·03	114	0·38	—	—	—	5	11	21	413	122
4	0·04	53	0·51	—	—	1	2	5	13	185	48
11	0·04	113	0·38	—	—	1	17	16	32	339	107
6	0·12	17	0·33	1	—	—	1	—	5	49	20
25	0·03	460	0·48	—	—	—	67	14	147	1,477	358
92	0·06	923	0·57	45	—	9	17	8	255	2,744	1,203
5	0·02	182	0·76	—	—	2	3	1	21	368	78–20
2	0·03	23	0·29	—	—	—	—	—	2	73	28
7	0·07	42	0·40	—	—	—	2	1	11	108	33
10	0·04	114	0·50	—	—	—	1	1	37	337	65
72	0·06	560	0·48	—	—	1	53	41	175	1,894	537
10	0·03	86	0·29	—		1	5	3	20	268	65
8	0·04	116	0·57	—	—	—	4	8	20	347	73
—	—	15	0·33	—	—	—	—	1	4	55	18
7	0·02	201	0·56	—	—	2	5	—	62	551	208
17	0·05	209	0·61	—	—	4	2	5	57	359	141
4	0·03	75	0·62	—	—	—	9	—	13	156	39–30
—	—	4	0·23	—	—	—	—	—	—	21	10
8	0·04	74	0·33	—	—	—	6	11	49	379	71
8	0·02	124	0·35	—	—	—	9	1	33	644	133
14	0·04	122	0·32	—	—	—	21	2	67	437	114
1	0·01	22	0·29	—	—	—	1	1	12	112	21
27	0·04	320	0·49	—	—	2	8	6	126	889	322
5	0·03	55	0·30	—	—	1	2	7	23	237	52
3	0·03	35	0·34	—	—	—	8	3	4	168	54
22	0·03	257	0·40	—	—	—	33	16	63	837	254
2	0·01	70	0·32	—	—	—	4	3	18	330	120–40
3	0·02	50	0·32	—	—	—	7	1	11	253	61
20	0·07	192	0·64	—	—	—	11	5	62	433	148
1	0·02	38	0·65	—	—	—	1	1	—	59	9
14	0·05	87	0·32	—	—	—	16	2	25	354	79
17	0·06	130	0·48	—	—	1	4	11	70	419	115
5	0·03	75	0·52	1	—	—	1	3	27	167	48
2	0·01	126	0·46	—	—	2	3	—	17	281	120
61	0·04	856	0·61	—	—	2	9	9	302	1,913	959
711	0·04	8,151	0·48	52	—	40	470	322	2,391	24,796	8,748

Port cases.

—	Estimated Civil Population in the middle of 1916.	Scarlet Fever.		Diphtheria.		Enteric Fever.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
Anglesey	48,029	81	1·69	41	0·85	22	0·46
50–Brecknockshire	56,175	178	3·17	39	0·69	19	0·34
Cardiganshire	55,270	61	1·10	66	1·19	4	0·07
Carmarthenshire	160,587	583	3·63	158	0·98	18	0·11
Carnarvonshire	112,115	110	0·98	152	1·36	17	0·15
Denbighshire	136,955	235	1·72	145	1·06	5	0·04
Flintshire	90,478	190	2·10	293	3·24	12	0·13
Glamorganshire	752,700	2,313	3·07	1,148	1·53	138	0·18
Merionethshire	40,432	46	1·14	112	2·77	2	0·05
Monmouthshire	316,081	1,750	5·54	257	0·81	98	0·31
Montgomeryshire	48,553	73	1·50	31	0·64	5	0·10
60–Pembrokeshire	84,552	163	1·93	100	1·18	16	0·19
Radnorshire	20,917	29	1·39	4	0·19	—	—
AGGREGATE OF WELSH ADMINISTRATIVE COUNTIES (INCLUDING MONMOUTHSHIRE).	1,922,844	5,812	3·02	2,546	1·32	356	0·19
PORT SANITARY DISTRICTS	—	39	—	33	—	126	—
NAVAL AND MILITARY CASES NOTIFIED TO MEDICAL OFFICERS OF HEALTH (NOT INCLUDED IN THE ABOVE TOTAL FOR ENGLAND AND WALES).	—	1,783	—	1,633	—	893	—

IN ADMINISTRATIVE COUNTIES—*cont.*

Puerperal Fever.		Erysipelas.		Small-pox cases.	Typhus Fever cases.	Continued Fever cases.	Cerebro-spinal Fever cases.	Poliomyelitis cases.	Ophthalmia Neonatorum cases.	Pulmonary Tuberculosis cases.	Other Tuberculosis cases.
Cases.	Rate.	Cases.	Rate.								
2	0·04	6	0·12	—	—	—	—	—	8	58	19
2	0·04	14	0·25	—	—	—	—	—	1	34	7–50
—	—	6	0·11	—	—	—	2	—	—	189	49
15	0·09	68	0·42	—	—	—	2	—	13	282	67
4	0·04	39	0·35	—	—	—	1	—	9	224	50
8	0·06	49	0·36	—	—	1	2	1	9	123	46
4	0·04	44	0·49	—	—	—	1	1	11	93	17
50	0·07	345	0·46	10	—	2	7	2	120	897	298
—	—	36	0·89	—	—	—	—	—	3	63	28
13	0·04	127	0·40	1	—	1	1	2	76	801	225
1	0·02	17	0·35	—	—	—	—	1	4	64	17
4	0·05	21	0·25	—	1	—	2	—	1	91	27–60
1	0·05	4	0·19	—	—	—	1	—	—	17	9
104	0·05	776	0·40	11	1	4	19	7	255	2,936	859
3	—	28	—	14	—	3	1	1	2	185	41
—	—	468	—	10	4	3	778	15	—	1,706	122

TABLE

Statistics of Infectious

	Estimated Population in the middle of 1916.	Scarlet Fever.		Diphtheria.		Enteric Fever.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
AGGREGATE OF 82 COUNTY BOROUGHS.	11,453,793	25,370	2·21	16,600	1·45	1,790	0·16
Barnsley	49,183	51	1·04	50	1·02	1	0·02
Barrow-in-Furness	83,179	179	2·15	130	1·56	3	0·04
Bath, City of..	61,831	125	2·02	140	2·26	10	0·16
Birkenhead	134,404	203	1·51	99	0·74	17	0·13
Birmingham, City of	847,555	1,865	2·20	993	1·17	29	0·03
Blackburn	121,066	154	1·27	53	0·44	14	0·12
Blackpool	63,052	142	2·25	43	0·68	7	0·11
Bolton	169,081	311	1·84	114	0·67	39	0·23
Bootle	71,135	174	2·45	75	1·05	4	0·06
10–Bournemouth	70,715	79	1·12	101	1·43	1	0·01
Bradford, City of	271,105	315	1·16	516	1·90	71	0·26
Brighton	115,224	185	1·61	174	1·51	6	0·05
Bristol, City of	343,688	625	1·82	405	1·18	17	0·05
Burnley	100,183	177	1·77	96	0·96	35	0·35
Burton-upon-Trent	44,352	45	1·01	72	1·62	4	0·09
Bury	53,463	112	2·09	48	0·90	5	0·09
Canterbury, City of	24,051	18	0·75	35	1·46	3	0·12
Carlisle, City of	49,721	225	4·53	142	2·86	3	0·06
Chester, City of	36,886	57	1·55	168	4·55	—	—
20–Coventry, City of	120,441	391	3·25	332	2·76	10	0·08
Croydon	175,765	300	1·71	309	1·76	12	0·07
Darlington	59,734	69	1·16	185	3·10	8	0·13
Derby	117,027	282	2·41	434	3·71	16	0·14
Dewsbury	51,855	69	1·33	51	0·98	6	0·12
Dudley..	49,865	88	1·76	4	0·08	2	0·04
Eastbourne	45,933	137	2·98	118	2·57	6	0·13
East Ham	139,959	271	1·94	226	1·61	7	0·05
Exeter, City of	53,872	134	2·49	28	0·52	1	0·02
Gateshead	118,821	339	2·85	82	0·69	11	0·09
30–Gloucester, City of..	47,256	39	0·83	84	1·78	5	0·11
Great Yarmouth	47,514	52	1·09	92	1·94	24	0·51
Grimsby	69,959	149	2·13	108	1·54	9	0·13
Halifax	97,047	171	1·76	77	0·79	11	0·11
Hastings	49,979	105	2·10	120	2·40	—	—
Huddersfield..	107,969	155	1·44	175	1·62	19	0·18
Ipswich	72,245	164	2·27	71	0·98	14	0·19
Kingston-upon-Hull, City of ..	265,764	626	2·36	360	1·35	82	0·31
Leeds, City of	438,254	881	2·01	420	0·96	51	0·12
Leicester	217,537	643	2·96	113	0·52	9	0·04
40–Lincoln, City of	55,078	145	2·63	76	1·38	2	0·04
Liverpool, City of	732,780	2,155	2·94	1,106	1·51	75	0·10
Manchester, City of	682,608	1,291	1·89	639	0·94	103	0·15
Middlesbrough	115,548	409	3·54	366	3·17	34	0·29
Newcastle-upon-Tyne, City of..	272,259	698	2·56	265	0·97	72	0·26
Northampton	86,128	259	3·01	137	1·59	8	0·09
Norwich, City of	112,901	228	2·02	253	2·24	23	0·20
Nottingham, City of	235,613	420	1·78	195	0·83	58	0·25
Oldham	136,126	149	1·09	140	1·03	5	0·04
Oxford, City of	47,446	27	0·57	31	0·65	5	0·11
50–Plymouth	184,473	369	2·00	357	1·94	39	0·21
Portsmouth	197,843	393	1·99	676	3·42	78	0·39
Preston..	109,935	392	3·57	224	2·04	45	0·41
Reading	85,075	97	1·14	61	0·72	75	0·88
Rochdale	90,000	63	0·70	251	2·79	12	0·13
Rotherham	63,338	98	1·55	67	1·06	18	0·28
St. Helen's	89,919	736	8·19	536	5·96	11	0·12
Salford..	214,229	435	2·03	205	0·96	43	0·20
Sheffield, City of	465,494	841	1·81	816	1·75	58	0·12
Smethwick	70,547	175	2·48	59	0·84	1	0·01
60–Southampton	116,391	188	1·62	170	1·46	23	0·20
Southend-on-Sea	74,083	135	1·82	51	0·69	6	0·08
Southport	64,473	146	2·26	84	1·30	7	0·11
South Shields	109,332	363	3·32	41	0·38	7	0·06
Stockport	115,599	305	2·64	70	0·61	14	0·12
Stoke-on-Trent	219,755	721	3·28	866	3·94	31	0·14
Sunderland	145,277	268	1·84	90	0·62	19	0·13
Tynemouth	57,192	130	2·27	53	0·93	64	1·12
Wakefield	47,293	51	1·08	85	1·80	21	0·44
Wallasey	83,442	119	1·43	66	0·79	11	0·13
70–Walsall..	89,506	320	3·58	75	0·84	7	0·08
Warrington	69,874	233	3·33	92	1·32	11	0·16
West Bromwich	66,918	79	1·18	28	0·42	1	0·01
West Ham	287,969	398	1·38	607	2·11	39	0·14
West Hartlepool	62,654	61	0·97	36	0·57	8	0·13
Wigan	83,203	820	9·86	37	0·44	85	1·02
Wolverhampton	93,023	153	1·64	125	1·34	3	0·03
Worcester, City of	44,539	52	1·17	35	0·79	10	0·22
York, City of..	77,177	318	4·12	42	0·54	25	0·32
AGGREGATE OF 78 COUNTY BOROUGHS IN ENGLAND.	11,011,710	24,347	2·21	15,956	1·45	1,729	0·16
Cardiff	180,341	479	2·66	372	2·06	26	0·14
80–Merthyr Tydfil	74,387	120	1·61	31	0·42	17	0·23
Newport (Mon.)	79,287	218	2·75	130	1·64	12	0·15
Swansea	108,068	206	1·91	111	1·03	6	0·06
AGGREGATE OF 4 COUNTY BOROUGHS IN WALES AND MONMOUTH.	442,083	1,023	2·31	644	1·46	61	0·14

Diseases in County Boroughs.

Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases	Erysipelas. Rate.	Small-pox Cases	Typhus Fever Cases.	Continued Fever Cases.	Cerebro-spinal Fever Cases.	Polio-myelitis Cases.	Ophthalmia Neonatorum Cases.	Pulmonary Tuberculosis Cases.	Other Tuberculosis Cases.
902	0·08	6,710	0·59	71	3	14	388	169	4,208	31,018	10,046
2	0·04	20	0·41	—	—	—	—	—	8	52	14
3	0·04	79	0·95	—	—	—	1	—	3	77	19
2	0·03	48	0·78	—	—	—	8	—	11	119	32
4	0·03	93	0·69	—	—	—	2	2	65	314	128
169	0·20	640	0·76	—	—	—	35	20	330	3,451	465
4	0·03	65	0·54	—	—	—	2	1	2	145	44
5	0·08	17	0·27	1	—	—	2	1	18	132	37
5	0·03	82	0·48	—	—	—	—	—	28	228	72
5	0·07	27	0·38	—	—	—	2	3	38	232	98
4	0·06	18	0·25	—	—	—	8	2	7	240	31-10
32	0·12	165	0·61	—	—	3	2	1	86	485	376
4	0·03	49	0·43	—	—	—	6	3	23	308	111
20	0·06	186	0·54	—	—	—	24	3	88	1,106	356
2	0·02	83	0·83	—	—	—	—	1	18	140	107
2	0·05	31	0·70	—	—	—	1	1	20	104	48
2	0·04	30	0·56	1	—	—	—	—	24	104	33
1	0·04	17	0·71	—	—	—	1	—	11	6	7
4	0·08	43	0·86	—	—	—	—	1	8	190	55
2	0·05	13	0·35	—	—	—	1	—	10	42	15
8	0·07	53	0·44	—	—	—	1	—	40	460	83-20
8	0·05	62	0·35	—	—	—	12	3	45	330	61
1	0·02	29	0·49	—	—	—	1	—	18	77	69
14	0·12	64	0·55	—	—	1	8	—	101	293	74
3	0·06	13	0·25	—	—	—	—	—	13	98	15
2	0·04	28	0·56	—	—	—	1	—	14	67	31
1	0·02	13	0·28	—	—	—	4	3	12	95	49
1	0·01	88	0·63	—	—	—	6	10	18	200	51
—	—	21	0·39	—	—	—	1	—	19	117	34
6	0·05	74	0·62	—	—	—	—	8	27	234	191
1	0·02	36	0·76	—	—	—	2	1	18	78	9-30
—	—	35	0·74	—	—	—	—	—	16	74	22
—	—	14	0·20	—	—	1	—	—	5	95	36
6	0·06	48	0·49	—	—	—	1	—	14	109	74
2	0·04	18	0·36	—	—	—	3	3	12	97	16
3	0·03	38	0·35	—	—	—	2	—	41	148	55
5	0·07	36	0·50	—	—	—	14	2	26	169	28
12	0·05	141	0·53	—	—	1	6	4	94	416	119
25	0·06	231	0·53	—	—	—	5	—	89	1,045	317
15	0·07	169	0·78	—	—	—	5	1	60	720	125
1	0·02	42	0·76	—	—	—	2	—	5	123	28-40
52	0·07	579	0·79	—	2	—	38	9	516	2,458	627
114	0·17	316	0·46	1	—	—	9	5	516	3,488	1,236
8	0·07	45	0·39	—	—	—	—	1	37	450	178
22	0·08	180	0·66	—	—	—	21	5	73	633	337
8	0·09	66	0·77	—	—	—	8	—	19	186	49
3	0·03	45	0·40	—	—	—	6	1	25	150	17
12	0·05	204	0·87	—	—	1	4	—	112	307	62
9	0·07	102	0·75	1	—	—	—	—	28	404	119
—	—	15	0·32	—	—	—	3	3	14	50	25
8	0·04	115	0·62	—	—	—	10	—	24	376	166-50
5	0·03	85	0·43	—	—	1	35	—	35	806	337
3	0·03	61	0·55	1	—	—	2	—	38	298	54
18	0·09	46	0·54	—	—	—	18	4	16	151	34
2	0·02	37	0·41	—	—	—	—	3	16	194	84
2	0·03	36	0·57	—	—	1	—	1	13	120	56
10	0·11	84	0·93	—	—	—	3	—	61	204	137
13	0·06	115	0·54	8	—	—	8	1	61	929	292
48	0·10	329	0·71	—	—	—	2	10	258	1,341	430
10	0·14	35	0·50	—	—	1	2	1	27	186	119
8	0·07	47	0·40	1	—	—	4	4	78	273	49-60
7	0·09	17	0·23	—	—	—	4	4	16	219	57
3	0·05	35	0·51	—	—	—	—	1	14	117	41
5	0·05	53	0·48	4	—	—	3	1	52	295	206
8	0·07	36	0·31	—	—	—	1	1	31	167	94
16	0·07	175	0·80	—	—	2	3	—	219	622	153
5	0·03	84	0·58	—	—	—	3	2	58	409	206
2	0·03	38	0·66	—	—	—	1	—	17	97	66
4	0·08	18	0·38	1	—	—	—	—	9	141	45
2	0·02	22	0·26	—	—	—	—	—	10	163	41
4	0·04	59	0·66	—	—	—	—	3	40	404	100-70
10	0·14	52	0·74	—	1	—	1	1	16	141	68
2	0·03	35	0·52	—	—	—	—	—	8	152	40
11	0·04	190	0·66	—	—	1	14	21	57	653	258
4	0·06	18	0·29	—	—	—	3	—	42	102	106
6	0·07	59	0·71	—	—	—	—	—	12	176	104
3	0·03	44	0·47	—	—	—	—	1	18	250	40
2	0·04	31	0·70	—	—	—	2	3	12	77	25
2	0·03	29	0·38	—	—	—	4	—	16	138	91
837	0·08	6,496	0·59	19	3	13	381	160	4,099	29,847	9,684
9	0·05	90	0·60	49	—	1	2	2	39	367	138
10	0·13	41	0·55	—	—	—	2	—	11	163	58-80
5	0·06	24	0·30	3	—	—	—	—	36	248	89
41	0·38	59	0·55	—	—	—	3	7	23	393	77
65	0·15	214	0·48	52	—	1	7	9	109	1,171	362

TABLE showing the number of cases of certain INFECTIOUS DISEASES notified in each sanitary area in ENGLAND and WALES during the 52 weeks ended 1st January, 1916, and the ATTACK-RATES per 1000 of the population.

Cases of Membranous Croup are included under the heading of Diphtheria.

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of London.													
ADMINISTRATIVE COUNTY	4,237,387	1	0·00	8762	2·07	8,741	2·06	457	0·11	276	0·07	2,845	0·67
CITY OF LONDON	20,113	–	–	34	1·69	25	1·24	2	0·10	1	0·05	7	0·35
METROPOLITAN BOROUGHS:—													
Battersea	159,402	–	–	352	2·21	359	2·25	14	0·09	10	0·06	94	0·59
Bermondsey	113,661	–	–	253	2·23	264	2·32	11	0·10	2	0·02	100	0·88
Bethnal Green	115,552	–	–	396	3·43	383	3·31	18	0·16	16	0·14	159	1·38
Camberwell..	249,749	–	–	495	1·98	462	1·85	12	0·05	11	0·04	170	0·68
Chelsea	57,298	–	–	109	1·90	101	1·76	8	0·14	2	0·03	28	0·49
Deptford	107,696	–	–	305	2·83	255	2·37	6	0·06	5	0·05	103	0·96
Finsbury	74,230	–	–	201	2·71	189	2·55	4	0·05	4	0·05	56	0·75
Fulham	149,428	1	0·01	285	1·91	312	2·09	5	0·03	22	0·15	71	0·48
Greenwich	94,452	–	–	193	2·04	369	3·91	14	0·15	6	0·06	58	0·61
Hackney	209,636	–	–	411	1·96	360	1·72	28	0·13	8	0·04	157	0·75
Hammersmith	117,965	–	–	208	1·76	215	1·82	6	0·05	8	0·07	48	0·41
Hampstead	81,470	–	–	136	1·67	99	1·22	6	0·07	2	0·02	39	0·48
Holborn	38,161	–	–	66	1·73	100	2·62	9	0·24	2	0·05	22	0·58
Islington	309,359	–	–	638	2·06	588	1·90	32	0·10	21	0·07	151	0·49
Kensington	152,144	–	–	211	1·39	153	1·01	20	0·13	10	0·07	86	0·57
Lambeth	283,729	–	–	507	1·79	418	1·47	19	0·07	21	0·07	116	0·41
Lewisham	162,901	–	–	304	1·87	250	1·53	11	0·07	6	0·04	73	0·45
Paddington	130,668	–	–	273	2·09	209	1·60	21	0·16	8	0·06	104	0·80
Poplar	155,095	–	–	310	2·00	340	2·19	19	0·12	17	0·11	159	1·03
St. Marylebone	98,573	–	–	118	1·20	134	1·36	13	0·13	–	–	72	0·73
St. Pancras	196,812	–	–	441	2·24	429	2·18	36	0·18	18	0·09	106	0·54
Shoreditch	99,932	–	–	315	3·15	308	3·08	11	0·11	3	0·03	131	1·31
Southwark	177,166	–	–	300	1·69	440	2·48	13	0·07	16	0·09	168	0·95
Stepney	258,395	–	–	729	2·82	932	3·61	37	0·14	10	0·04	242	0·94
Stoke Newington	49,776	–	–	86	1·73	109	2·19	3	0·06	4	0·08	19	0·38
Wandsworth	310,858	–	–	683	2·20	521	2·00	46	0·15	20	0·06	151	0·49
Westminster	132,853	–	–	177	1·33	152	1·14	24	0·18	8	0·06	60	0·45
Woolwich	130,313	–	–	226	1·73	265	2·03	9	0·07	15	0·12	95	0·73
County of Bedford													
ADMINISTRATIVE COUNTY	186,002	–	–	240	1·29	823	4·42	22	0·12	7	0·04	94	0·51
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	114,683	–	–	118	1·03	601	5·24	5	0·04	2	0·02	33	0·29
AGGREGATE OF RURAL DISTRICTS.	71,319	–	–	122	1·71	222	3·11	17	0·24	5	0·07	61	0·86
BOROUGHS AND URBAN DISTRICTS:—													
Ampthill	2,107	–	–	–	–	54	25·63	–	–	–	–	1	0·47
Bedford	36,142	–	–	42	1·16	110	3·04	–	–	–	–	7	0·19
Biggleswade .. .	4,978	–	–	3	0·60	23	4·62	–	–	–	–	4	0·0
Dunstable	7,727	–	–	11	1·42	29	3·75	1	0·13	–	–	–	–
Kempston	4,550	–	–	8	1·76	44	9·67	–	–	–	–	4	0·88
Leighton Buzzard ..	6,197	–	–	10	1·61	39	6·29	1	0·16	–	–	1	0·16
Luton	52,982	–	–	44	0·83	302	5·70	3	0·06	2	0·04	16	0·30
RURAL DISTRICTS:—													
Ampthill	18,015	–	–	7	0·39	67	3·72	–	–	–	–	17	0·94
Bedford	17,820	–	–	53	2·97	64	3·59	1	0·06	1	0·06	7	0·39
Biggleswade	19,221	–	–	46	2·39	13	0·68	13	0·68	4	0·21	31	1 61
Eaton Bray	3,550	–	–	1	0·28	29	8·17	2	0·56	–	–	2	0·56
Eaton Socon	3,092	–	–	3	0·97	–	–	–	–	–	–	2	0·65
Luton	9,621	–	–	12	1·25	49	5·09	1	0·10	–	–	2	0·21

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Berks.													
ADMINISTRATIVE COUNTY	173,359	–	–	466	2·69	222	1·28	16	0·09	6	0·03	42	0·24
COUNTY BOROUGH:—													
Reading	85,075	–	–	97	1·14	61	0·72	75	0·88	8	0·09	46	0·54
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	51,655	–	–	164	3·17	54	1·05	2	0·04	3	0·06	14	0·27
AGGREGATE OF RURAL DISTRICTS.	121,704	–	–	302	2·48	168	1·38	14	0·12	3	0·02	28	0·23
BOROUGHS AND URBAN DISTRICTS:—													
Abingdon	6,186	–	–	40	6·47	16	2·59	1	0·16	2	0·32	2	0·32
Maidenhead	14,423	–	–	38	2·63	11	0·76	1	0·07	1	0·07	4	0·28
Newbury	11,107	–	–	58	5·22	18	1·62	–	–	–	–	2	0·18
New Windsor	10,214	–	–	7	0·69	2	0·20	–	–	–	–	–	–
Wallingford	2,442	–	–	–	–	2	0·82	–	–	–	–	–	–
Wantage	3,357	–	–	4	1·19	5	1·49	–	–	–	–	3	0·89
Wokingham	3,926	–	–	17	4·33	–	–	–	–	–	–	3	0·76
RURAL DISTRICTS:—													
Abingdon	8,773	–	–	27	3·08	12	1·37	–	–	–	–	–	–
Bradfield	12,622	–	–	8	0·63	7	0·55	1	0·08	–	–	–	–
Cookham	11,969	–	–	64	5·35	7	0·58	–	–	–	–	3	0·25
Easthampstead	14,471	–	–	39	2·70	19	1·31	–	–	1	0·07	1	0·07
*Faringdon (part of) ..	9,595	–	–	46	4·79	24	2·50	2	0·21	–	–	3	0·31
Hungerford	7,935	–	–	–	–	14	1·76	–	–	1	0·13	2	0·25
Newbury	10,069	–	–	55	5·46	12	1·19	5	0·50	–	–	2	0·20
Wallingford	6,065	–	–	9	1·48	2	0·33	1	0·16	–	–	2	0·33
Wantage	10,741	–	–	18	1·68	44	4·10	–	–	–	–	2	0·19
Windsor	13,872	–	–	4	0·29	4	0·29	–	–	1	0·07	11	0·79
Wokingham	15,592	–	–	32	2·05	23	1·48	5	0·32	–	–	2	0·13
County of Buckingham.													
ADMINISTRATIVE COUNTY	206,697	–	–	461	2·23	306	1·48	15	0·07	4	0·02	85	0·41
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	74,963	–	–	209	2·79	155	2·07	6	0·08	3	0·04	25	0·33
AGGREGATE OF RURAL DISTRICTS.	131,734	–	–	252	1·91	151	1·15	9	0·07	1	0·01	60	0·46
BOROUGHS AND URBAN DISTRICTS:—													
Aylesbury	10,321	–	–	78	7·56	30	2·91	1	0·10	1	0·10	2	0·19
Beaconsfield	3,092	–	–	3	0·97	–	–	–	–	–	–	–	–
Bletchley	4,756	–	–	8	1·68	8	1·68	2	0·42	–	–	6	1·26
Buckingham	2,901	–	–	11	3·79	5	1·72	–	–	–	–	1	0·34
Chepping Wycombe ..	19,404	–	–	71	3·66	87	4·48	1	0·05	2	0·10	1	0·05
Chesham	7,658	–	–	17	2·22	–	–	–	–	–	–	5	0·65
Eton	2,050	–	–	–	–	2	0·98	–	–	–	–	1	0·49
Linslade	2,141	–	–	3	1·40	8	3·74	2	0·93	–	–	–	–
Marlow	4,520	–	–	5	1·11	–	–	–	–	–	–	2	0·44
Newport Pagnell	3.912	–	–	–	–	5	1·28	–	–	–	–	3	0·77
Slough	14,208	–	–	13	0·91	10	0·70	–	–	–	–	4	0·28
RURAL DISTRICTS:—													
Amersham	17,382	–	–	18	1·04	12	0·69	–	–	–	–	3	0·17
Aylesbury	14,052	–	–	64	4·56	12	0·85	3	0·21	–	–	3	0·21
Buckingham	7,356	–	–	11	1·50	–	–	–	–	–	–	3	0·41
Eton	23,917	–	–	11	0·46	48	2·01	2	0·08	–	–	5	0·21
Hambleden	1,742	–	–	–	–	5	2·87	–	–	–	–	–	–
Long Crendon	3,749	–	–	8	2·13	–	–	–	–	–	–	–	–
Newport Pagnell	17,697	–	–	67	3·79	37	2·09	1	0·06	–	–	32	1·81
Stratford and Wolverton	10,294	–	–	4	0·39	1	0·10	–	–	–	–	13	1·26
Wing	5,428	–	–	6	1·11	11	2·03	1	0·18	–	–	–	–
Winslow	6,249	–	–	24	3·84	5	0·80	–	–	1	0·16	–	–
Wycombe	23,868	–	–	39	1·63	20	0·84	2	0·08	–	–	1	0·04

* The remaining part of the Rural District of Faringdon is in the Administrative County of Gloucester. The figures for the entire rural district are:—

10,602	–	–	46	4·34	24	2·26	2	0·19	–	–	3	0·28

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Cambridge.													
ADMINISTRATIVE COUNTY	118,371	–	–	162	1·37	139	1·17	6	0·05	3	0·03	53	0·45
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	52,236	–	–	85	1·63	102	1·95	2	0·04	–	–	25	0·48
AGGREGATE OF RURAL DISTRICTS.	66,135	–	–	77	1·16	37	0·56	4	0·06	3	0·05	28	0·42
BOROUGHS AND URBAN DISTRICTS;—													
Cambridge	52,236	–	–	85	1·63	102	1·95	2	0·04	–	–	25	0·48
RURAL DISTRICTS:—													
Caxton and Arrington ..	6,843	–	–	13	1·90	–	–	–	–	–	–	2	0·29
Chesterton	21,738	–	–	21	0·97	15	0·69	2	0·09	1	0·05	10	0·46
Linton..	9,228	–	–	6	0·65	3	0·33	–	–	1	0·11	6	0·65
Melbourn	7,963	–	–	12	1·51	1	0·13	–	–	–	–	–	–
Newmarket	18,035	–	–	22	1·22	17	0·94	2	0·11	1	0·06	9	0·50
Swavesey	2,328	–	–	3	1·29	1	0·43	–	–	–	–	1	0·43
County of Isle of Ely.													
ADMINISTRATIVE COUNTY	66,053	–	–	83	1·26	59	0·89	20	0·30	2	0·03	34	0·51
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	34,256	–	–	30	0·88	43	1·26	19	0·55	–	–	17	0·50
AGGREGATE OF RURAL DISTRICTS.	31,797	–	–	53	1·67	16	0·50	1	0·03	2	0·06	17	0·53
BOROUGHS AND URBAN DISTRICTS:—													
Chatteris	4,885	–	–	1	0·20	10	2·05	–	–	–	–	4	0·82
Ely	7,134	–	–	13	1·82	12	1·68	1	0·14	–	–	–	–
March..	8,162	–	–	10	1·23	3	0·37	–	–	–	–	5	0·61
Whittlesey	3,842	–	–	3	0·78	3	0·78	–	–	–	–	3	0·78
Wisbech	10,233	–	–	3	0·29	15	1·47	18	1·76	–	–	5	0·49
RURAL DISTRICTS:—													
Ely	12,052	–	–	1	0·08	7	0·58	–	–	–	–	10	0·83
North Witchford	4,755	–	–	–	–	1	0·21	1	0·21	–	–	2	0·42
Thorney	1,928	–	–	15	7·78	3	1·56	–	–	–	–	2	1·04
Whittlesey	3,143	–	–	5	1·59	2	0·64	–	–	–	–	–	–
Wisbech	9,919	–	–	32	3·23	3	0·30	–	–	2	0·20	3	0·30
County of Chester.													
ADMINISTRATIVE COUNTY	572,509	3	0·01	1,688	2·95	1,128	1·97	85	0·15	62	0·11	371	0·65
COUNTY BOROUGHS:—													
Birkenhead	134,404	–	–	203	1·51	99	0·74	17	0·13	4	0·03	93	0·69
Chester	36,886	–	–	57	1·55	168	4·55	–	–	2	0·05	13	0·35
Stockport	115,599	–	–	305	2·64	70	0·61	14	0·12	8	0·07	36	0·31
Wallasey	83,442	–	–	119	1·43	66	0·79	11	0·13	2	0·02	22	0·26
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	397,777	–	–	1,356	3·41	890	2·24	78	0·20	47	0·12	334	0·84
AGGREGATE OF RURAL DISTRICTS.	174,732	–	–	332	1·90	238	1·36	7	0·04	15	0·09	37	0·21
BOROUGHS AND URBAN DISTRICTS:—													
Alderley Edge	2,872	–	–	1	0·35	1	0·35	–	–	–	–	–	–
Alsager	2,690	–	–	7	2·60	4	1·49	–	–	–	–	–	–
Altrincham	17,356	–	–	10	0·58	6	0·35	–	–	2	0·12	7	0·40
Ashton upon Mersey ..	7,471	–	–	7	0·94	4	0·54	–	–	–	–	5	0·67
Bollington	4,892	–	–	–	–	8	1·64	–	–	–	–	1	0·20
Bowdon	2,798	–	–	15	5·36	3	1·07	–	–	–	–	–	–
Bredbury and Romiley ..	8,959	–	–	39	4·35	9	1·00	–	–	–	–	12	1·34

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Chester—*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Bromborough	2,134	–	–	–	–	–	–	–	–	–	–	–	–
Buglawton	1,407	–	–	1	0·71	1	0·71	–	–	–	–	–	–
Cheadle and Gatley ..	10,183	–	–	7	0·69	5	0·49	1	0·10	1	0·10	3	0·29
Compstall	847	–	–	1	1·18	1	1·18	2	2·36	–	–	–	–
Congleton	10,664	–	–	40	3·75	12	1·13	2	0·19	3	0·28	6	0·56
Crewe..	44,435	–	–	184	4·14	177	3·98	2	0·05	2	0·05	14	0·32
Dukinfield	18,049	–	–	26	1·44	8	0·44	8	0·44	2	0·11	12	0·66
Ellesmere Port and Whitby.	10,406	–	–	19	1·83	7	0·67	1	0·10	–	–	9	0·86
Hale	8,743	–	–	12	1·37	3	0·34	–	–	1	0·11	1	0·11
Handforth	932	–	–	–	–	–	–	–	–	–	–	–	–
Hazel Grove and Bramhall.	9,629	–	–	15	1·56	2	0·21	2	0·21	–	–	3	0·31
Higher Bebington ..	1,597	–	–	18	11·27	2	1·25	–	–	–	–	1	0·63
Hollingworth	2,413	–	–	–	–	–	–	–	–	–	–	–	–
Hoole	5,584	–	–	11	1·97	33	5·91	2	0·36	–	–	1	0·18
Hoylake and West Kirby	13,457	–	–	42	3·12	8	0·59	–	–	–	–	4	0·30
Hyde	31,476	–	–	36	1·14	19	0·60	2	0·06	1	0·03	22	0·70
Knutsford	4,800	–	–	15	3·13	4	0·83	–	–	–	–	5	1·04
Lower Bebington	12,866	–	–	15	1·17	15	1·17	1	0·08	4	0·31	6	0·47
Lymm	4,723	–	–	44	9·32	20	4·23	–	–	1	0·21	3	0·64
Macclesfield..	31,241	–	–	52	1·66	40	1·28	3	0·10	1	0·03	9	0·29
Marple	6,124	–	–	2	0·33	–	–	–	–	–	–	–	–
Middlewich	4,734	–	–	1	0·21	4	0·84	1	0·21	–	–	2	0·42
Mottram in Longdendale	2,859	–	–	1	0·35	–	–	–	–	–	–	–	–
Nantwich	6,823	–	–	10	1·47	11	1·61	–	–	–	–	3	0·44
Neston and Parkgate ..	4,432	–	–	4	0·90	1	0·23	–	–	–	–	1	0·23
Northwich	16,924	–	–	28	1·65	27	1·60	1	0·06	5	0·30	7	0·41
Runcorn	17,138	–	–	66	3·85	14	0·82	4	0·23	1	0·06	6	0·35
Sale	15,169	–	–	15	0·99	14	0·92	1	0·07	2	0·13	5	0·33
Sandbach	5,601	–	–	3	0·54	7	1·25	–	–	–	–	1	0·18
Stalybridge	23,626	3	0·13	15	0·63	10	0·42	3	0·13	3	0·13	11	0·47
Tarporley	2,334	–	–	–	–	–	–	–	–	–	–	1	0·43
Wilmslow	7,931	–	–	4	0·50	3	0·38	–	–	1	0·13	1	0·13
Winsford	9,876	–	–	2	0·20	4	0·41	–	–	1	0·10	8	0·81
Yeardsley cum Whaley ..	1,582	–	–	4	2·53	–	–	–	–	–	–	–	–
RURAL DISTRICTS :—													
Bucklow	21,250	–	–	34	1·60	22	1·04	–	–	1	0·05	4	0·19
Chester	10,745	–	–	8	0·74	18	1·68	1	0·09	–	–	2	0·19
Congleton	12,305	–	–	18	1·46	6	0·49	–	–	–	–	5	0·41
Disley	2,875	–	–	2	0·70	3	1·04	–	–	–	–	3	1·04
Macclesfield..	16,189	–	–	10	0·62	12	0·74	1	0·06	–	–	1	0·06
Malpas	4,228	–	–	–	–	5	1·18	–	–	–	–	–	–
Nantwich	23,618	–	–	68	2·88	50	2·12	1	0·04	–	–	1	0·04
Northwich	21,857	–	–	91	4·17	73	3·34	–	–	8	0·37	4	0·18
Runcorn	27,313	–	–	63	2·31	22	0·81	1	0·04	3	0·11	9	0·33
Tarvin	12,441	–	–	13	1·04	9	0·72	1	0·08	–	–	–	–
Tintwistle	2,137	–	–	4	1·87	–	–	–	–	–	–	1	0·47
Wirral	19,784	–	–	21	1·06	18	0·91	2	0·10	3	0·15	7	0·35
County of Cornwall.													
ADMINISTRATIVE COUNTY	296,132	–	–	360	1·22	622	2·10	33	0·11	15	0·05	113	0·38
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	128,550	–	–	157	1·22	337	2·62	20	0·16	9	0·07	70	0·54
AGGREGATE OF RURAL DISTRICTS.	167,582	–	–	203	1·21	285	1·70	13	0·08	6	0·04	43	0·26
BOROUGHS AND URBAN DISTRICTS :—													
Bodmin	3,908	–	–	1	0·26	6	1·54	1	0·26	2	0·51	7	1·79
Callington	1,591	–	–	–	–	–	–	–	–	–	–	–	–
Camborne	14,930	–	–	15	1·00	15	1·00	3	0·20	–	–	29	1·94
Falmouth	10,559	–	–	2	0·19	106	10·04	–	–	–	–	3	0·28
Fowey	1,808	–	–	1	0·55	2	1·11	–	–	–	–	–	–
Hayle	950	–	–	–	–	–	–	–	–	–	–	1	1·05
Helston	2,472	–	–	–	–	–	–	–	–	–	–	–	–

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Cornwall—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Launceston	3,768	–	–	1	0·27	2	0·53	–	–	1	0·27	1	0·27
Liskeard	3,966	–	–	–	–	–	–	–	–	–	–	–	–
Looe	2,519	–	–	14	5·56	4	1·59	7	2·78	–	–	1	0·40
Lostwithiel	1,189	–	–	–	–	–	–	–	–	–	–	1	0·84
Ludgvan	2,087	–	–	–	–	1	0·48	–	–	–	–	–	–
Madron	3,489	–	–	5	1·43	17	4·87	–	–	–	–	2	0·57
Newquay	4,205	–	–	2	0·48	3	0·71	–	–	–	–	–	–
Padstow	1,503	–	–	7	4·66	–	–	–	–	1	0·67	2	1·33
Paul	5,242	–	–	–	–	50	9·54	2	0·38	–	–	3	0·57
Penryn	2,819	–	–	1	0·35	8	2·84	1	0·35	–	–	–	–
Penzance	11,001	–	–	9	0·82	13	1·18	5	0·45	–	–	1	0·09
Phillack	3,626	–	–	–	–	–	–	–	–	–	–	1	0·28
Redruth	10,015	–	–	20	2·00	46	4·59	–	–	–	–	3	0·30
St. Austell	2,804	–	–	2	0·71	3	1·07	–	–	–	–	1	0·36
St. Ives	6,285	–	–	53	8·43	2	0·32	–	–	–	–	5	0·80
St. Just	5,219	–	–	11	2·11	13	2·49	1	0·19	1	0·19	3	0·57
Saltash	3,501	–	–	1	0·29	9	2·57	–	–	–	–	1	0·29
Stratton and Bude ..	2,678	–	–	–	–	–	–	–	–	1	0·37	–	–
Torpoint	4,090	–	–	3	0·73	14	3·42	–	–	1	0·24	3	0·73
Truro	10,074	–	–	8	0·79	21	2·08	–	–	2	0·20	2	0·20
Wadebridge..	2,252	–	–	1	0·44	2	0·89	–	–	–	–	–	–
RURAL DISTRICTS:—													
Bodmin	9,698	–	–	4	0·41	2	0·21	–	–	–	–	4	0·41
Calstock	4,435	–	–	27	6·09	5	1·13	–	–	1	0·23	3	0·68
Camelford	6,905	–	–	–	–	3	0·43	–	–	–	–	2	0·29
East Kerrier	7,525	–	–	14	1·86	51	6·78	2	0·27	1	0·13	3	0·40
Helston	15,675	–	–	33	2·11	4	0·26	1	0·06	–	–	1	0·06
*Holsworthy (part of) ..	299	–	–	–	–	–	–	–	–	–	–	–	–
Launceston	6,618	–	–	4	0·60	6	0·91	–	–	1	0·15	–	–
Liskeard	13,675	–	–	12	0·88	13	0·95	–	–	–	–	4	0·29
Redruth	16,643	–	–	24	1·44	86	5·17	1	0·06	–	–	6	0·36
St. Austell	28,994	–	–	37	1·28	32	1·10	4	0·14	2	0·07	8	0·28
St. Columb Major	10,620	–	–	17	1·60	3	0·28	–	–	–	–	–	–
St. Germans..	11,025	–	–	12	1·09	28	2·54	1	0·09	–	–	4	0·36
Stratton	4,724	–	–	–	–	–	–	1	0·21	–	–	–	–
Truro	18,921	–	–	10	0·53	23	1·22	2	0·11	1	0·05	8	0·42
West Penwith	10,208	–	–	9	0·88	29	2·84	1	0·10	–	–	–	–
Isles of Scilly	1,617	–	–	–	–	–	–	–	–	–	–	–	–
County of Cumberland.													
ADMINISTRATIVE COUNTY	199,223	–	–	945	4·74	212	1·06	41	0·21	3	0·02	120	0·60
COUNTY BOROUGH:—													
Carlisle	49,721	–	–	225	4·53	142	2·86	3	0·06	4	0·08	43	0·86
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	111,639	–	–	503	4·51	116	1·04	39	0·35	2	0·02	79	0·71
AGGREGATE OF RURAL DISTRICTS.	87,584	–	–	442	5·05	96	1·10	2	0·02	1	0·01	41	0·47
BOROUGHS AND URBAN DISTRICTS:—													
Arlecdon and Frizington	4,820	–	–	17	3·53	–	–	–	–	–	–	2	0·41
Aspatria	3,296	–	–	108	32·77	1	0·30	1	0·30	–	–	6	1·82
Cleator Moor	7,761	–	–	20	2·58	4	0·52	1	0·13	–	–	9	1·16
Cockermouth	4,347	–	–	5	1·15	11	2·53	–	–	–	–	3	0·69
Egremont	6,056	–	–	8	1·32	6	0·99	–	–	–	–	8	1·32
Harrington	3,840	–	–	6	1·56	1	0·26	6	1·56	–	–	–	–
Holme Cultram	4,308	–	–	12	2·79	3	0·70	–	–	–	–	2	0·46
Keswick	4,154	–	–	55	13·24	11	2·65	–	–	–	–	1	0·24
Maryport	10,144	–	–	87	8·58	9	0·89	6	0·59	1	0·10	3	0·30
Millom	9,331	–	–	53	5·68	21	2·25	1	0·11	–	–	5	0·54
Penrith	8,051	–	–	8	0·99	5	0·62	–	–	–	–	3	0·37
Whitehaven..	17,541	–	–	29	1·65	2	0·11	21	1·20	–	–	10	0·57
Wigton	3,276	–	–	8	2·44	–	–	3	0·92	–	–	–	–
Workington	24,714	–	–	87	3·52	42	1·70	–	–	1	0·04	27	1·09

* The remaining part of the Rural District of Holsworthy is in the Administrative County of Devonshire.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Cumberland—*continued.*													
RURAL DISTRICTS :—													
Alston with Garrigill ..	2,598	–	–	–	–	12	4·62	–	–	–	–	–	–
Bootle	5,158	–	–	6	1·16	3	0·58	–	–	–	–	4	0·78
Brampton	7,587	–	–	13	1·71	3	0·40	1	0·13	–	–	–	–
Carlisle	10,450	–	–	45	4·31	22	2·11	–	–	–	–	5	0·48
Cockermouth	20,578	–	–	239	11·61	17	0·83	–	–	1	0·05	14	0·68
Longtown	5,778	–	–	4	0·69	7	1·21	–	–	–	–	–	–
Penrith	11,870	–	–	16	1·35	27	2·27	–	–	–	–	4	0·34
Whitehaven..	13,158	–	–	45	3·42	3	0·23	1	0·08	–	–	7	0·53
Wigton	10,407	–	–	74	7·11	2	0·19	–	–	–	–	7	0·67
County of Derby.													
ADMINISTRATIVE COUNTY	539,588	–	–	1,489	2·76	992	1·84	70	0·13	24	0·04	250	0·46
COUNTY BOROUGH :— Derby	117,027	–	–	282	2·41	434	3·71	16	0·14	14	0·12	64	0·55
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	277,593	–	–	654	2·36	555	2·00	41	0·15	12	0·04	133	0·48
AGGREGATE OF RURAL DISTRICTS.	261,995	–	–	835	3·19	437	1·67	29	0·11	12	0·05	117	0·45
BOROUGHS AND URBAN DISTRICTS :—													
Alfreton	18,974	–	–	77	4·06	33	1·74	4	0·21	–	–	8	0·42
Alvaston and Boulton ..	1,495	–	–	–	–	1	0·67	–	–	–	–	–	–
Ashbourne	3,745	–	–	–	–	1	0·27	3	0·80	–	–	2	0·53
Bakewell	2,699	–	–	–	–	3	1·11	1	0·37	–	–	5	1·85
Baslow and Bubnell ..	753	–	–	1	1·33	2	2·66	–	–	–	–	–	–
Belper	11,492	–	–	28	2·44	42	3·65	–	–	–	–	4	0·35
Bolsover	10,649	–	–	50	4·70	23	2·16	10	0·94	–	–	12	1·13
Bonsall	1,132	–	–	–	–	3	2·65	–	–	–	–	–	–
Brampton and Walton ..	2.200	–	–	4	1·82	1	0·45	–	–	–	–	1	0·45
Buxton	9,182	–	–	9	0·98	2	0·22	1	0·11	1	0·11	1	0·11
Chesterfield	36,786	–	–	67	1·82	125	3·40	11	0·30	5	0·14	16	0·43
Clay Cross	7,911	–	–	14	1·77	3	0·38	–	–	1	0·13	3	0·38
Dronfield	4,178	–	–	5	1·20	10	2·39	–	–	–	–	–	–
Fairfield	4,124	–	–	9	2·18	–	–	–	–	–	–	–	–
Glossop	19,808	–	–	78	3·94	6	0·30	3	0·15	1	0·05	18	0·91
Heage	3,535	–	–	9	2·55	30	8·49	–	–	–	–	–	–
Heanor	20,379	–	–	96	4·71	40	1·96	–	–	–	–	15	0·74
Ilkeston	30,118	–	–	24	0·80	33	1·10	2	0·07	1	0·03	2	0·07
Long Eaton	17,735	–	–	25	1·41	30	1·69	–	–	–	–	8	0·45
Matlock	5,699	–	–	7	1·23	36	6·32	2	0·35	–	–	–	–
Matlock Bath and Scarthin Nick	1,524	–	–	1	0·66	4	2·62	–	–	–	–	–	–
New Mills	7,986	–	–	2	0·25	2	0·25	1	0·13	–	–	2	0·25
North Darley	2,955	–	–	1	0·34	11	3·72	1	0·34	–	–	–	–
Ripley	12,301	–	–	26	2·11	13	1·06	–	–	1	0·08	5	0·41
South Darley	732	–	–	–	–	–	–	–	–	–	–	–	–
Swadlincote	18,572	–	–	22	1·18	40	2·15	–	–	1	0·05	18	0·97
Whittington and Newbold	17,410	–	–	95	5·46	54	3·10	2	0·11	–	–	12	0·69
Wirksworth	3,519	–	–	4	1·14	7	1·99	–	–	1	0·28	1	0·28
RURAL DISTRICTS :—													
Ashbourne	9,996	–	–	2	0·20	8	0·80	–	–	–	–	2	0·20
Bakewell	18,641	–	–	15	0·80	25	1·34	1	0·05	–	–	2	0·11
Belper..	24,562	–	–	93	3·79	35	1·42	1	0·04	–	–	14	0·57
Blackwell	38,590	–	–	191	4·95	83	2·15	2	0·05	3	0·08	14	0·36
Chapel en le Frith ..	14,824	–	–	31	2·09	11	0·74	–	–	–	–	1	0·07
Chesterfield	70,931	–	–	345	4·86	163	2·30	7	0·10	5	0·07	35	0·49
Clowne	16,905	–	–	43	2·54	31	1·83	3	0·18	–	–	16	0·95
*Codnor Park and Shipley (parishes).	1,405	–	–	7	4·98	4	2·85	–	–	–	–	–	–
Glossop Dale	3,656	–	–	1	0·27	–	–	11	3·01	–	–	1	0·27
Hartshorn and Seals ..	7,852	–	–	19	2·42	12	1·53	–	–	–	–	8	1·02
Hayfield	3,939	–	–	18	4·57	1	0·25	–	–	–	–	2	0·51
Norton	4,093	–	–	1	0·24	3	0·73	1	0·24	–	–	3	0·73
Repton	14,077	–	–	39	2·77	20	1·42	–	–	2	0·14	3	0·21
Shardlow	30,055	–	–	26	0·87	41	1·36	3	0·10	2	0·07	16	0·53
Sudbury	2,469	–	–	4	1·62	–	–	–	–	–	–	–	–

* These parishes are administered by the Rural District Council of Basford (Notts.).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Devon.													
ADMINISTRATIVE COUNTY	387,187	–	–	471	1·22	546	1·41	70	0·18	4	0·01	120	0·31
COUNTY BOROUGHS :—													
Exeter	53,872	–	–	134	2·49	28	0·52	1	0·02	–	–	21	0·39
Plymouth	184,473	–	–	369	2·00	357	1·94	39	0·21	8	0·04	115	0·62
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	186,655	–	–	159	0·85	256	1·37	21	0·11	1	0·01	62	0·33
AGGREGATE OF RURAL DISTRICTS.	200,532	–	–	312	1·56	290	1·45	49	0·24	3	0·01	58	0·29
BOROUGHS AND URBAN DISTRICTS :—													
Ashburton	2,113	–	–	4	1·89	1	0·47	–	–	–	–	1	0·47
Axminster	1,926	–	–	8	4·15	–	–	–	–	–	–	–	–
Bampton	1,419	–	–	1	0·70	–	–	2	1·41	–	–	–	–
Barnstaple	13,012	–	–	7	0·54	41	3·15	2	0·15	–	–	9	0·69
Bideford	8,067	–	–	9	1·12	14	1·74	1	0·12	–	–	2	0·25
Brixham	7,711	–	–	–	–	14	1·82	2	0·26	–	–	5	0·65
Buckfastleigh	2,145	–	–	–	–	15	6·99	–	–	–	–	–	–
Budleigh Salterton ..	2,295	–	–	–	–	–	–	1	0·44	–	–	–	–
Crediton	3,205	–	–	–	–	2	0·62	–	–	–	–	–	–
Dartmouth	5,275	–	–	3	0·57	3	0·57	–	–	–	–	2	0·38
Dawlish	3,511	–	–	–	–	4	1·14	–	–	–	–	–	–
Exmouth	11,520	–	–	17	1·48	8	0·69	1	0·09	–	–	5	0·43
Great Torrington	2,710	–	–	11	4·06	–	–	1	0·37	–	–	1	0·37
Holsworthy..	1,321	–	–	–	–	–	–	–	–	–	–	3	2·27
Honiton	2,794	–	–	4	1·43	1	0·36	2	0·72	–	–	–	–
Ilfracombe	8,505	–	–	–	–	9	1·06	–	–	–	–	1	0·12
Ivybridge	1,517	–	–	–	–	–	–	–	–	–	–	–	–
Kingsbridge	2,825	–	–	2	0·71	21	7·43	–	–	–	–	2	0·71
Lynton	1,657	–	–	1	0·60	2	1·21	–	–	–	–	1	0·60
Newton Abbot	12,469	–	–	19	1·52	25	2·00	–	–	–	–	4	0·32
Northam	5,228	–	–	–	–	3	0·57	–	–	–	–	4	0·77
Okehampton	2,961	–	–	14	4·73	1	0·34	–	–	–	–	–	–
Ottery St. Mary	3,299	–	–	6	1·82	17	5·15	2	0·61	–	–	4	1·21
Paignton	11,683	–	–	8	0·68	4	0·34	–	–	–	–	4	0·34
Salcombe	1,809	–	–	2	1·11	–	–	1	0·55	–	–	1	0·55
Seaton	1,695	–	–	–	–	–	–	–	–	–	–	–	–
Sidmouth	4,532	–	–	–	–	7	1·54	1	0·22	–	–	–	–
South Molton	2,509	–	–	–	–	2	0·80	–	–	–	–	1	0·40
Tavistock	4,054	–	–	3	0·74	15	3·70	–	–	–	–	5	1·23
Teignmouth	8,860	–	–	12	1·35	8	0·90	2	0·23	–	–	2	0·23
Tiverton	8,858	–	–	5	0·56	2	0·23	1	0·11	–	–	2	0·23
Torquay	31,540	–	–	22	0·70	36	1·14	2	0·06	1	0·03	3	0·10
Totnes	3,630	–	–	1	0·28	1	0·28	–	–	–	–	–	–
RURAL DISTRICTS :—													
Axminster	9,199	–	–	7	0·76	1	0·11	–	–	–	–	2	0·22
Barnstaple	17,072	–	–	9	0·53	26	1·52	–	–	–	–	1	0·06
Bideford	5,779	–	–	11	1·90	3	0·52	1	0·17	1	0·17	2	0·35
Broadwoodwidger ..	2,026	–	–	2	0·99	–	–	1	0·49	–	–	4	1·97
Crediton	9,778	–	–	8	0·82	2	0·20	1	0·10	–	–	7	0·72
Culmstock	3,131	..	.	3	0·96	5	1·60	6	1·92	–	–	–	–
*Holsworthy (part of) ..	6,498	–	–	–	–	–	–	–	–	–	–	3	0·46
Honiton	8,716	–	–	12	1·38	5	0·57	1	0·11	–	–	2	0·23
Kingsbridge..	10,795	–	–	25	2·32	10	0·93	1	0·09	1	0·09	7	0·65
Newton Abbot	18,043	–	–	52	2·88	59	3·27	2	0·11	–	–	7	0·39
Okehampton	12,369	–	–	17	1·37	9	0·73	1	0·08	–	–	3	0·24
Plympton St. Mary ..	18,368	–	–	66	3·59	86	4·68	17	0·93	–	–	2	0·11
St. Thomas	22,445	–	–	27	1·20	25	1·11	13	0·58	–	–	9	0·40
South Molton	9,930	–	–	56	5·64	13	1·31	–	–	1	0·10	2	0·20
Tavistock	13,778	–	–	4	0·29	21	1·52	2	0·15	–	–	3	0·22
Tiverton	13,864	–	–	5	0·36	8	0·58	1	0·07	–	–	2	0·14
Torrington	8,070	–	–	3	0·37	3	0·37	–	–	–	–	2	0·25
Totnes	10,671	–	–	5	0·47	14	1·31	2	0·19	–	–	–	–

* The remaining part of the Rural District of Holsworthy is in the Administrative County of Cornwall. The figures for the entire District are :—

	6,797	–	–	–	–	–	–	–	–	–	–	3	0·44

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases	Erysipelas. Rate.
County of Dorset.													
ADMINISTRATIVE COUNTY	201,393	–	–	319	1·58	155	0·77	27	0·13	10	0·05	76	0·38
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	105,836	–	–	149	1·41	96	0·91	12	0·11	6	0·06	39	0·37
AGGREGATE OF RURAL DISTRICTS.	95,557	–	–	170	1·78	59	0·62	15	0·16	4	0·04	37	0·39
BOROUGHS AND URBAN DISTRICTS:—													
Blandford Forum ..	3,239	–	–	8	2·47	10	3·09	–	–	–	–	1	0·31
Bridport	5,249	–	–	41	7·81	2	0·38	–	–	–	–	–	–
Dorchester	8,745	–	–	17	1·94	6	0·69	–	–	–	–	3	0·34
Lyme Regis .. .	2,135	–	–	2	0·94	25	11·71	–	–	–	–	–	–
Poole	38,907	–	–	41	1·05	44	1·13	8	0·21	2	0·05	21	0·54
Portland	8,813	–	–	–	–	2	0·23	–	–	–	–	4	0·45
Shaftesbury..	1,677	–	–	–	–	–	–	–	–	–	–	–	–
Sherborne	5,325	–	–	9	1·69	–	–	–	–	–	–	–	–
Swanage	4,480	–	–	3	0·67	–	–	1	0·22	–	–	1	0·22
Wareham	1,995	–	–	–	–	–	–	2	1·00	–	–	2	1·00
Weymouth and Melcombe Regis.	21,911	–	–	28	1·28	7	0·32	–	–	4	0·18	5	0·23
Wimborne Minster ..	3,360	–	–	–	–	–	–	1	0·30	–	–	2	0·60
RURAL DISTRICTS:—													
Beaminster	8,088	–	–	19	2·35	–	–	2	0·25	–	–	4	0·49
Blandford	7,914	–	–	17	2·15	8	1·01	–	–	–	–	7	0·88
Bridport	6,184	–	–	54	8·73	1	0·16	1	0·16	1	0·16	2	0·32
Cerne	4,200	–	–	4	0·95	3	0·71	–	–	–	–	1	0·24
Dorchester	7,371	–	–	10	1·36	20	2·71	10	1·36	–	–	7	0·95
Poole	6,787	–	–	5	0·74	7	1·03	–	–	–	–	3	0·44
Shaftesbury..	10,343	–	–	13	1·26	5	0·48	–	–	–	–	3	0·29
Sherborne	5,108	–	–	2	0·39	9	1·76	1	0·20	–	–	–	–
Sturminster	7,124	–	–	14	1·97	4	0·56	–	–	–	–	2	0·28
Wareham and Purbeck ..	10,032	–	–	5	0·50	–	–	–	–	1	0·10	2	0·20
Weymouth	8,433	–	–	17	2·02	–	–	–	–	2	0·24	3	0·36
Wimborne and Cranborne	13,973	–	–	10	0·72	2	0·14	1	0·07	–	–	3	0·21
County of Durham.													
ADMINISTRATIVE COUNTY	836,711	1	0·00	2768	3·31	1378	1·65	531	0·63	24	0·03	485	0·58
COUNTY BOROUGHS:—													
Darlington	59,734	–	–	69	1·16	185	3·10	8	0·13	1	0·02	29	0·49
Gateshead	118,821	–	–	339	2·85	82	0·69	11	0·09	6	0·05	74	0·62
South Shields	109,332	4	0·04	363	3·32	41	0·38	7	0·06	5	0·05	53	0·48
Sunderland	145,277	–	–	268	1·84	90	0·62	19	0·13	5	0·03	84	0·58
West Hartlepool	62,654	–	–	61	0·97	36	0·57	8	0·13	4	0·06	18	0·29
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	455,307	–	–	1436	3·15	759	1·67	135	0·30	12	0·03	271	0·60
AGGREGATE OF RURAL DISTRICTS.	381,404	–	–	1332	3·49	619	1·62	396	1·04	12	0·03	214	0·56
BOROUGHS AND URBAN DISTRICTS:—													
Annfield Plain	15,461	–	–	39	2·52	34	2·20	5	0·32	–	–	21	1·36
Barnard Castle	4,041	–	–	2	0·49	10	2·47	1	0·25	–	–	1	0·25
Benfieldside	7,339	–	–	70	9·54	68	9·27	2	0·27	–	–	11	1·50
Bishop Auckland	12,372	–	–	10	0·81	22	1·78	9	0·73	1	0·08	9	0·73
Blaydon	30,193	–	–	151	5·00	46	1·52	4	0·13	2	0·07	22	0·73
Brandon and Byshottles	16,805	–	–	72	4·28	33	1·96	6	0·36	–	–	4	0·24
Chester le Street	13,894	–	–	18	1·30	18	1·30	5	0·36	1	0·07	11	0·79
Consett	10,435	–	–	38	3·64	53	5·08	4	0·38	–	–	7	0·67
Crook	11,453	–	–	40	3·49	70	6·11	–	–	–	–	5	0·44
Durham	14,524	–	–	10	0·69	6	0·41	1	0·07	–	–	5	0·34
Felling	24,203	–	–	63	2·60	9	0·37	28	1·16	–	–	21	0·87
Hartlepool	18,592	–	–	11	0·59	4	0·22	1	0·05	1	0·05	4	0·22
Hebburn	22,346	–	–	104	4·65	15	0·67	12	0·54	1	0·04	22	0·98
Hetton	15,110	–	–	47	3·11	15	0·99	12	0·79	–	–	7	0·46
Houghton le Spring ..	8,738	–	–	25	2·86	11	1·26	3	0·34	–	–	7	0·80
Jarrow	34,499	–	–	86	2·49	11	0·32	3	0·09	1	0·03	32	0·93
Leadgate	4,656	–	–	12	2·58	17	3·65	–	–	–	–	–	–
Ryton	11,285	–	–	73	6·47	41	3·63	6	0·53	1	0·09	6	0·53
Seaham Harbour	15,450	–	–	6	0·39	3	0·19	4	0·26	–	–	1	0·06

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Durham—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Shildon and East Thickley.	12,562	–	–	4	0·32	16	1·27	10	0·80	–	–	12	0·96
Southwick on Wear ..	13,557	–	–	36	2·66	9	0·66	2	0·15	–	–	2	0·15
Spennymoor	16,520	–	–	13	0·79	26	1·57	5	0·30	–	–	7	0·42
Stanhope	1,683	–	–	1	0·59	4	2·38	–	–	–	–	1	0·59
Stanley	22,474	–	–	203	9·03	34	1·51	2	0·09	–	–	12	0·53
Stockton on Tees	57,247	–	–	81	1·41	72	1·26	7	0·12	1	0·02	16	0·28
Tanfield	9,474	–	–	43	4·54	16	1·69	1	0·11	–	–	8	0·84
Tow Law	3,316	–	–	15	4·52	3	0·90	–	–	–	–	5	1·51
Whickham	18,562	–	–	139	7·49	59	3·18	1	0·05	2	0·11	9	0·48
Willington	8,516	1	0·12	24	2·82	34	3·99	1	0·12	1	0·12	3	0·35
RURAL DISTRICTS:—													
Auckland	56,181	–	–	146	2·60	114	2·03	8	0·14	3	0·05	33	0·59
Barnard Castle	10,990	–	–	1	0·09	2	0·18	2	0·18	1	0·09	4	0·36
Chester le Street	62,818	–	–	486	7·74	167	2·66	23	0·37	3	0·05	41	0·65
Darlington	8,796	–	–	11	1·25	7	0·80	1	0·11	1	0·11	6	0·68
Durham	28,473	–	–	95	3·34	23	0·81	20	0·70	–	–	5	0·18
Easington	65,145	–	–	172	2·64	48	0·74	25	0·38	–	–	42	0·64
Hartlepool	2,614	–	–	4	1·53	1	0·38	3	1·15	–	–	–	–
Houghton le Spring ..	24,444	–	–	55	2·25	31	1·27	12	0·49	–	–	17	0·70
Lanchester	29,647	–	–	93	3·14	101	3·41	12	0·40	1	0·03	16	0·54
Sedgefield	31,478	–	–	113	3·59	17	0·54	57	1·81	–	–	22	0·70
South Shields	15,164	–	–	72	4·75	9	0·59	220	14·51	1	0·07	12	0·79
Stockton	10,722	–	–	16	1·49	13	1·21	2	0·19	–	–	–	–
Sunderland	26,400	–	–	51	1·93	71	2·69	4	0·15	2	0·08	12	0·45
Weardale	8,532	–	–	17	1·99	15	1·76	7	0·82	–	–	4	0·47
County of Essex.													
ADMINISTRATIVE COUNTY	836,507	1	0·00	1,584	1·89	1,508	1·80	91	0·11	44	0·05	368	0·44
COUNTY BOROUGHS:—													
East Ham	139,959	–	–	271	1·94	226	1·61	7	0·05	1	0·01	88	0·63
Southend on Sea	74,083	–	–	135	1·82	51	0·69	6	0·08	7	0·09	17	0·23
West Ham	287,969	–	–	398	1·38	607	2·11	39	0·14	11	0·04	190	0·66
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	593,740	–	–	1,182	1·99	1,227	2·07	70	0·12	34	0·06	273	0·46
AGGREGATE OF RURAL DISTRICTS.	242,767	–	–	402	1·66	281	1·16	21	0·09	10	0·04	95	0·39
BOROUGHS AND URBAN DISTRICTS:—													
Barking Town	33,875	–	–	50	1·48	118	3·48	6	0·18	1	0·03	37	1·09
Braintree	6,334	–	–	24	3·79	5	0·79	–	–	–	–	1	0·16
Brentwood	5,994	–	–	16	2·67	12	2·00	–	–	1	0·17	3	0·50
Brightlingsea	4,341	–	–	1	0·23	–	–	1	0·23	–	–	2	0·46
Buckhurst Hill	4,602	–	–	2	0·43	–	–	2	0·43	1	0·22	2	0·43
Burnham on Crouch ..	3,104	–	–	–	–	16	5·15	–	–	–	–	–	–
Chelmsford	19,237	–	–	33	1·72	76	3·95	5	0·26	–	–	5	0·26
Chingford	8,904	–	–	29	3·26	10	1·12	–	–	–	–	3	0·34
Clacton	8,776	–	–	17	1·94	3	0·34	1	0·11	–	–	2	0·23
Colchester	37,542	–	–	43	1·15	97	2·58	15	0·40	4	0·11	21	0·56
Epping	3,916	–	–	13	3·32	1	0·26	–	–	–	–	1	0·26
Frinton on Sea	1,590	–	–	–	–	1	0·63	–	–	–	–	2	1·26
Grays Thurrock	15,651	1	0·06	42	2·68	9	0·58	1	0·06	–	–	1	0·06
Halstead	5,699	–	–	31	5·44	1	0·18	–	–	–	–	–	–
Harwich	11,756	–	–	26	2·21	19	1·62	3	0·26	1	0·09	6	0·51
Ilford	79,774	–	–	137	1·72	162	2·03	9	0·11	6	0·08	27	0·34
Leyton	121,420	–	–	269	2·22	178	1·47	12	0·10	9	0·07	46	0·38
Loughton	5,436	–	–	13	2·39	–	–	4	0·74	–	–	–	–
Maldon	5,574	–	–	17	3·05	3	0·54	–	–	–	–	2	0·36
Romford	17,518	–	–	12	0·69	62	3·54	2	0·11	2	0·11	26	1·48
Saffron Walden	5,330	–	–	24	4·50	1	0·19	–	–	1	0·19	5	0·94
Shoeburyness	4,392	–	–	7	1·59	5	1·14	2	0·46	–	–	2	0·46
Tilbury	6,253	–	–	2	0·32	5	0·80	–	–	–	–	1	0·16
Waltham Holy Cross ..	7,098	–	–	9	1·27	12	1·69	–	–	–	–	–	–
Walthamstow	128,146	–	–	328	2·56	372	2·90	3	0·02	4	0·03	65	0·51

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Essex—*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Walton on the Naze ..	1,968	–	–	3	1·52	19	9·65	–	–	–	–	–	–
Wanstead	15,246	–	–	11	0·72	19	1·25	1	0·07	2	0·13	6	0·39
Witham	3,211	–	–	–	–	9	2·80	–	–	–	–	–	–
Wivenhoe	2,237	–	–	2	0·89	2	0·89	3	1·34	–	–	1	0·45
Woodford	18,816	–	–	21	1·12	10	0·53	–	–	2	0·11	6	0·32
RURAL DISTRICTS :—													
Belchamp	4,048	–	–	–	–	–	–	–	–	–	–	3	0·74
Billericay	18,363	–	–	38	2·07	17	0·93	5	0·27	–	–	10	0·54
Braintree	17,197	–	–	16	0·93	38	2·21	–	–	1	0·06	7	0·41
Bumpstead	2,273	–	–	2	0·88	1	0·44	–	–	1	0·44	1	0·44
Chelmsford	21,809	–	–	42	1·93	10	0·46	–	–	–	–	3	0·14
Dunmow	14,304	–	–	16	1·12	15	1·05	–	–	–	–	4	0·28
Epping	13,368	–	–	15	1·12	18	1·35	–	–	–	–	6	0·45
Halstead	9,196	–	–	10	1·09	6	0·65	3	0·33	–	–	4	0·43
Lexden and Winstree ..	18,303	–	–	31	1·69	13	0·71	1	0·05	1	0·05	8	0·44
Maldon	14,600	–	–	22	1·51	9	0·62	–	–	–	–	4	0·27
Ongar	9,523	–	–	6	0·63	18	1·89	2	0·21	–	–	3	0·32
Orsett	19,968	–	–	76	3·81	19	0·95	4	0·20	1	0·05	5	0·25
Rochford	18,234	–	–	13	0·71	10	0·55	–	–	1	0·05	8	0·44
Romford	25,869	–	–	53	2·05	64	2·47	–	–	5	0·19	22	0·85
Saffron Walden	9,622	–	–	20	2·08	17	1·77	–	–	–	–	–	–
Stansted	6,584	–	–	9	1·37	25	3·80	–	–	–	–	1	0·15
Tendring	19,506	–	–	33	1·69	1	0·05	6	0·31	–	–	6	0·31
County of Gloucester.													
ADMINISTRATIVE COUNTY	300,513	–	–	494	1·64	304	1·01	39	0·13	10	0·03	114	0·38
COUNTY BOROUGHS :—													
Bristol	343,688	–	–	625	1·82	405	1·18	17	0·05	20	0·06	186	0·54
Gloucester	47,256	–	–	39	0·83	84	1·78	5	0·11	1	0·02	36	0·76
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	89,059	–	–	106	1·19	94	1·06	22	0·25	1	0·01	41	0·46
AGGREGATE OF RURAL DISTRICTS.	211,454	–	–	388	1·83	210	0·99	17	0·08	9	0·04	73	0·35
BOROUGHS AND URBAN DISTRICTS :—													
Awre	1,007	–	–	–	–	–	–	–	–	–	–	–	–
Charlton Kings	4,206	–	–	1	0·24	7	1·66	–	–	–	–	4	0·95
Cheltenham	42,045	–	–	57	1·36	69	1·64	15	0·36	–	–	25	0·59
Cirencester	6,638	–	–	1	0·15	8	1·21	–	–	–	–	6	0·90
Coleford	2,535	–	–	6	2·37	–	–	–	–	–	–	–	–
Kingswood	12,520	–	–	8	0·64	2	0·16	–	–	–	–	3	0·24
Nailsworth	2,799	–	–	5	1·79	1	0·36	–	–	1	0·36	1	0·36
Newnham	1,005	–	–	6	5·97	–	–	–	–	–	–	–	–
Stow on the Wold ..	1,087	–	–	–	–	–	–	–	–	–	–	–	–
Stroud	7,581	–	–	18	2·37	5	0·66	–	–	–	–	2	0·26
Tetbury	1,540	–	–	2	1·30	–	–	–	–	–	–	–	–
Tewkesbury . ..	4,511	–	–	–	–	2	0·44	7	1·55	–	–	–	–
Westbury on Severn ..	1,585	–	–	2	1·26	–	–	–	–	–	–	–	–
RURAL DISTRICTS :—													
Campden	4,876	–	–	–	–	10	2·05	–	–	–	–	2	0·41
Cheltenham..	4,822	–	–	9	1·87	1	0·21	–	–	–	–	1	0·21
Chipping Sodbury ..	19,331	–	–	68	3·52	10	0·52	–	–	–	–	12	0·62
Cirencester	11,036	–	–	8	0·72	6	0·54	–	–	2	0·18	1	0·09
Dursley	11,680	–	–	7	0·60	8	0·68	1	0·09	–	–	10	0·86
East Dean and United Parishes.	19,493	–	–	26	1·33	56	2·87	1	0·05	–	–	6	0·31
*Faringdon (part of) ..	1,007	–	–	–	–	–	–	–	–	–	–	–	–
Gloucester	10,520	–	–	7	0·67	8	0·76	7	0·67	1	0·10	6	0·57
Lydney	8,667	–	–	40	4·62	21	2·42	2	0·23	–	–	2	0·23
Marston Sicca	1,595	–	–	8	5·02	–	–	–	–	–	–	–	–
Newent	6,453	–	–	33	5·11	7	1·08	1	0·15	1	0·15	6	0·93
Northleach	7,218	–	–	13	1·80	12	1·66	–	–	–	–	–	–
Pebworth	3,072	–	–	14	4·56	3	0·98	–	–	–	–	–	–

* The remaining part of the Rural District of Faringdon is in the Administrative County of Berkshire.

Notifications of Infectious Disease and Attack-Rates, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Gloucester —*continued.*													
Rural Districts :—													
*Stow on the Wold (part of)	5,973	–	–	33	5·52	15	2·51	–	–	2	0·33	1	0·17
Stroud	26,290	–	–	44	1·67	5	0·19	2	0·08	3	0·11	6	0·23
*Tetbury (part of)	3,284	–	–	5	1·52	2	0·61	–	–	–	–	–	–
*Tewkesbury (part of) ..	4,439	–	–	–	–	–	–	1	0·23	–	–	1	0·23
Thornbury	17,032	–	–	7	0·41	4	0·23	–	–	–	–	9	0·53
Warmley	16,954	–	–	17	1·00	12	0·71	1	0·06	–	–	6	0·35
West Dean	13,658	–	–	29	2·12	18	1·32	–	–	–	–	–	–
Wheatenhurst	5,599	–	–	13	2·32	4	0·71	–	–	–	–	1	0·18
*Winchcomb (part of) ..	8,455	–	–	7	0·83	8	0·95	1	0·12	–	–	3	0·35
County of Hereford.													
Administrative County	103,494	–	–	161	1·56	88	0·85	3	0·03	4	0·04	53	0·51
Aggregate of Boroughs and Urban Districts.	35,633	–	–	16	0·45	14	0·39	–	–	2	0·06	26	0·73
Aggregate of Rural Districts.	67,861	–	–	145	2·14	74	1·09	3	0·04	2	0·03	27	0·40
Boroughs and Urban Districts :—													
Bromyard	1,549	–	–	–	–	2	1·29	–	–	–	–	1	0·65
Hereford	20,537	–	–	8	0·39	7	0·34	–	–	1	0·05	21	1·02
Kington	1,509	–	–	3	1·99	2	1·33	–	–	–	–	–	–
Ledbury	2,773	–	–	–	–	1	0·36	–	–	1	0·36	1	0·36
Leominster	5,093	–	–	1	0·20	1	0·20	–	–	–	–	2	0·39
Ross	4,172	–	–	4	0·96	1	0·24	–	–	–	–	1	0·24
Rural Districts :—													
Bredwardine	1,802	–	–	11	6·10	1	0·55	–	–	–	–	1	0·55
Bromyard	7,133	–	–	11	1·54	1	0·14	–	–	–	–	–	–
Dore	5,819	–	–	16	2·75	2	0·34	–	–	–	–	7	1·20
Hereford	11,812	–	–	9	0·76	2	0·17	–	–	–	–	5	0·42
Kington	4,482	–	–	4	0·89	8	1·78	–	–	–	–	2	0·45
Ledbury	8,497	–	–	16	1·88	25	2·94	3	0·35	–	–	4	0·47
Leominster	7,431	–	–	4	0·54	26	3·50	–	–	–	–	4	0·54
Ross	9,693	–	–	60	6·19	8	0·83	–	–	–	–	3	0·30
Weobley	6,218	–	–	11	1·77	1	0·16	–	–	2	0·32	–	–
Whitchurch..	1,478	–	–	2	1·35	–	–	–	–	–	–	–	–
Wigmore	3,496	–	–	1	0·29	–	–	–	–	–	–	1	0·29
County of Hertford.													
Administrative County	298,072	–	–	394	1·32	487	1·63	24	0·08	11	0·04	113	0·38
Aggregate of Boroughs and Urban Districts.	198,773	–	–	291	1·46	350	1·76	11	0·06	10	0·05	77	0·39
Aggregate of Rural Districts.	99,299	–	–	103	1·04	137	1·38	13	0·13	1	0·01	36	0·36
Boroughs and Urban Districts :—													
Baldock	2,256	–	–	1	0·44	–	–	–	–	1	0·44	–	–
Barnet	11,113	–	–	6	0·54	8	0·72	–	–	–	–	5	0·45
Bishop Stortford	7,933	–	–	9	1·13	44	5·55	–	–	–	–	1	0·13
Bushey	6,974	–	–	11	1·58	13	1·86	2	0·29	–	–	2	0·29
Cheshunt	13,641	–	–	28	2·05	7	0·51	–	–	–	–	4	0·29
Chorleywood	2,095	–	–	12	5·73	2	0·95	–	–	–	–	–	–
East Barnet Valley ..	12,383	–	–	4	0·32	12	0·97	–	–	–	–	4	0·32
Great Berkhampstead ..	6,894	–	–	26	3·77	13	1·89	–	–	–	–	3	0·44
Harpenden	6,075	–	–	3	0·49	16	2·63	1	0·16	–	–	4	0·66
Hemel Hempstead ..	12,099	–	–	13	1·07	31	2·56	–	–	–	–	7	0·58
Hertford	9,234	–	–	15	1·62	9	0·97	–	–	3	0·32	6	0·65
Hitchen	11,081	–	–	9	0·81	61	5·50	2	0·18	1	0·09	8	0·72
Hoddesdon	4,969	–	–	–	–	10	2·01	1	0·20	1	0·20	2	0·40
Rickmansworth	6,844	–	–	9	1·32	–	–	1	0·15	–	–	–	–
Royston	3,543	–	–	2	0·56	–	–	3	0·85	–	–	1	0·28
St. Albans	23,823	–	–	34	1·43	32	1·34	–	–	–	–	5	0·21

* The remaining parts of the Rural Districts of Stow on the Wold, Tewkesbury and Winchcomb are in the Administrative County of Worcester, and the remaining part of the Rural District of Tetbury is in the Administrative County of Wiltshire. The figures for the entire Districts are :—

Stow on the Wold	6,248	–	–	33	5·28	15	2·40	–	–	2	0·32	1	0·16
Tetbury	3,597	–	–	5	1·39	2	0·56	–	–	–	–	–	–
Tewkesbury	6,461	–	–	–	–	–	–	1	0·15	–	–	2	0·31
Winchcomb	8,558	–	–	7	·82	8	0·93	1	0·12	–	–	3	0·35

Notifications of Infectious Disease and Attack-Rates, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Hertford—*continued.*													
Boroughs and Urban Districts :—													
Sawbridgeworth	2,166	-	-	3	1·39	3	1·39	-	-	-	-	1	0·46
Stevenage	4,844	-	-	2	0·41	-	-	-	-	-	-	5	1·03
Tring	4,028	-	-	14	3·48	3	0·74	-	-	-	-	2	0·50
Ware	5,342	-	-	15	2·81	9	1·68	-	-	-	-	5	0·94
Watford	41,436	-	-	75	1·81	77	1·86	1	0·02	4	0·10	12	0·29
Rural Districts :—													
Ashwell	3,726	-	-	-	-	-	-	1	0·27	-	-	2	0·54
Barnet	4,153	-	-	3	0·72	3	0·72	-	-	-	-	-	-
Berkhampstead	4,324	-	-	17	3·93	2	0·46	-	-	-	-	1	0·23
Buntingford..	4,527	-	-	-	-	8	1·77	-	-	-	-	-	-
Hadham	5,173	-	-	6	1·16	2	0·39	-	-	-	-	-	-
Hatfield	8,153	-	-	3	0·37	27	3·31	-	-	-	-	-	-
Hemel Hempstead ..	6,169	-	-	19	3·08	28	4·54	-	-	-	-	4	0·65
Hertford	7,035	-	-	6	0·85	2	0·28	-	-	-	-	1	0·14
Hitchin	21,223	-	-	9	0·42	24	1·13	9	0·42	1	0·05	2	0·09
St. Albans	10,122	-	-	3	0·79	24	2·37	1	0·10	-	-	2	0·20
Ware	10,031	-	-	6	0·60	12	1·20	-	-	-	-	4	0·40
Watford	12,340	-	-	26	2·11	5	0·41	2	0·16	-	-	20	1·62
Welwyn	2,323	-	-	-	-	-	-	-	-	-	-	-	-
County of Huntingdon.													
Administrative County	51,095	1	0·02	78	1·53	20	0·39	3	0·06	6	0·12	17	0·33
Aggregate of Boroughs and Urban Districts.	21,991	-	-	60	2·73	7	0·32	2	0·09	4	0·18	4	0·18
Aggregate of Rural Districts.	29,104	-	-	18	0·62	13	0·45	1	0·03	2	0·07	13	0·45
Boroughs and Urban Districts :—													
Godmanchester	1,887	-	-	-	-	-	-	-	-	-	-	-	-
Huntingdon	3,715	-	-	1	0·27	1	0·27	2	0·54	1	0·27	1	0·27
Old Fletton	4,897	-	-	23	4·70	2	0·41	-	-	1	0·20	-	-
Ramsey	5,025	-	-	25	4·98	-	-	-	-	1	0·20	2	0·40
St. Ives	2,701	-	-	8	2·96	2	0·74	-	-	1	0·37	-	-
St. Neots	3,766	-	-	3	0·80	2	0·53	-	-	-	-	1	0·27
Rural Districts :—													
Huntingdon	6,315	-	-	6	0·95	1	0·16	-	-	-	-	3	0·48
Norman Cross	5,103	-	-	2	0·39	1	0·20	-	-	1	0·20	3	0·59
*Oundle (part of) ..	1,012	-	-	-	-	-	-	-	-	1	0·99	1	0·99
St. Ives	8,903	-	-	3	0·34	3	0·34	-	-	-	-	4	0·45
St. Neots	6,556	1	0·15	6	0·92	8	1·22	1	0·15	-	-	2	0·31
†Stibbington (parish) ..	390	-	-	-	-	-	-	-	-	-	-	-	-
*Thrapston (part of) ..	825	-	-	-	-	-	-	-	-	-	-	-	-
County of Kent.													
Administrative County	964,254	-	-	1,803	1·87	1,583	1·64	204	0·21	25	0·03	460	0·48
County Borough :— Canterbury	24,051	-	-	18	0·75	35	1·46	3	0·12	1	0·04	17	0·71
Aggregate of Boroughs and Urban Districts.	670,898	-	-	1,346	2·01	1,136	1·69	165	0·25	21	0·03	331	0·49
Aggregate of Rural Districts.	293,356	-	-	457	1·56	447	1·52	39	0·13	4	0·01	129	0·44
Boroughs and Urban Districts :—													
Ashford	13,868	-	-	32	2·31	25	1·80	3	0·22	-	-	1	0·07
Beckenham	30,774	-	-	52	1·69	9	0·29	6	0·19	-	-	8	0·26
Bexley	18,698	-	-	117	6·26	17	0·91	-	-	-	-	7	0·37
Broadstairs and St. Peter's	8,991	-	-	26	2·89	31	3·45	1	0·11	-	-	7	0·78

* The remaining parts of the Rural Districts of Oundle and Thrapston are in the Administrative County of Northampton.

† This parish is administered by the Rural District Council of Barnack (Soke of Peterborough).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diph-theria.		Enteric Fever.		Puerperal Fever.		Ery-sipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Kent—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Bromley	32,169	–	–	28	0·87	45	1·40	1	0·03	2	0·06	20	0·62
Chatham	38,056	–	–	82	2·15	75	1·97	16	0·42	–	–	10	0·26
Cheriton	5,167	–	–	25	4·84	2	0·39	–	–	1	0·19	2	0·39
Chislehurst	8,286	–	–	9	1·09	6	0·72	1	0·12	–	–	6	0·72
Dartford	21,826	–	–	82	3·76	16	0·73	7	0·32	–	–	11	0·50
Deal	10,135	–	–	16	1·58	5	0·49	1	0·10	–	–	2	0·20
Dover	38,769	–	–	108	2·79	43	1·11	4	0·10	2	0·05	14	0·36
Erith	35,011	–	–	182	5·20	118	3·37	4	0·11	–	–	11	0·31
Faversham	11,472	–	–	20	1·74	22	1·92	5	0·44	–	–	9	0·78
Folkestone	34,418	–	–	64	1·86	59	1·71	1	0·03	4	0·12	21	0·61
Footscray	8,610	–	–	6	0·70	20	2·32	–	–	–	–	7	0·81
Gillingham	44,049	–	–	98	2·22	41	0·93	8	0·18	1	0·02	19	0·43
Gravesend	27,302	–	–	38	1·39	60	2·20	3	0·11	1	0·04	22	0·81
Herne Bay	7,052	–	–	11	1·56	15	2·13	–	–	–	–	4	0·57
Hythe..	6,819	–	–	23	3·37	12	1·76	–	–	1	0·15	2	0·29
Lydd	2,265	–	–	–	–	–	–	–	–	–	–	2	0·88
Maidstone	31,138	–	–	30	0·96	25	0·80	37	1·19	1	0·03	29	0·93
Margate	24,957	–	–	47	1·88	34	1·36	4	0·16	–	–	10	0·40
Milton Regis	6,763	–	–	2	0·30	20	2·96	–	–	1	0·15	6	0·89
New Romney	1,194	–	–	–	–	2	1·68	–	–	–	–	1	0·84
Northfleet	14,337	–	–	22	1·53	28	1·95	7	0·49	–	–	8	0·56
Penge	22,184	–	–	30	1·35	28	1·26	1	0·05	–	–	7	0·32
Queenborough	3,046	–	–	50	16·41	28	9·19	1	0·33	–	–	8	2·63
Ramsgate	24,798	–	–	12	0·48	34	1·37	2	0·08	1	0·04	27	1·09
Rochester	30,332	–	–	45	1·48	78	2·57	18	0·59	1	0·03	12	0·40
Royal Tunbridge Wells ..	32,316	–	–	9	0·28	51	1·58	3	0·09	2	0·06	11	0·34
*Sandgate (part of) ..	1,350	–	–	2	1·48	–	–	–	–	–	–	–	–
Sandwich	2,808	–	–	2	0·71	–	–	–	–	–	–	–	–
Sevenoaks	8,409	–	–	4	0·48	11	1·31	–	–	–	–	–	–
Sheerness	16,598	–	–	32	1·93	44	2·65	26	1·57	2	0·12	9	0·54
Sittingbourne	8,184	–	–	8	0·98	59	7·21	–	–	1	0·12	4	0·49
Southborough	6,357	–	–	3	0·47	9	1·42	1	0·16	–	–	4	0·63
Tenterden	3,053	–	–	2	0·66	–	–	–	–	–	–	1	0·33
Tonbridge	13,619	–	–	12	0·88	33	2·42	3	0·22	–	–	5	0·37
Walmer	3,812	–	–	5	1·31	3	0·79	–	–	–	–	1	0·26
Whitstable	7,964	–	–	7	0·88	22	2·76	1	0·13	–	–	3	0·38
Wrotham	3,942	–	–	3	0·76	6	1·52	–	–	–	–	–	–
RURAL DISTRICTS:—													
Blean	7,003	–	–	1	0·14	11	1·57	–	–	–	–	3	0·43
Bridge	8,898	–	–	14	1·57	16	1·80	–	–	–	–	4	0·45
Bromley	22,335	–	–	21	0·94	14	0·63	2	0·09	1	0·04	20	0·90
Cranbrook	12,092	–	–	12	0·99	59	4·88	1	0·08	–	–	6	0·50
Dartford	40,582	–	–	112	2·76	54	1·33	7	0·17	–	–	21	0·52
Dover	7,149	–	–	15	2·10	4	0·56	–	–	–	–	–	–
East Ashford	13,521	–	–	18	1·33	14	1·04	2	0·15	–	–	4	0·30
Eastry	12,379	–	–	10	0·81	9	0·73	1	0·08	–	–	6	0·48
Elham	7,330	–	–	12	1·64	1	0·14	1	0·14	–	–	6	0·82
Faversham	14,166	–	–	47	3·32	63	4·45	3	0·21	–	–	4	0·28
Hollingbourn	12,001	–	–	14	1·17	7	0·58	–	–	–	–	4	0·33
Hoo	3,931	–	–	1	0·25	2	0·51	–	–	–	–	–	–
Isle of Thanet	8,999	–	–	16	1·78	5	0·56	5	0·56	–	–	5	0·56
Maidstone	15,231	–	–	16	1·05	16	1·05	–	–	–	–	5	0·33
Malling	22,424	–	–	63	2·81	21	0·94	1	0·04	1	0·04	12	0·54
Milton	12,320	–	–	18	1·46	45	3·65	5	0·41	1	0·08	6	0·49
Romney Marsh	2,630	–	–	1	0·38	–	–	–	–	–	–	–	–
Sevenoaks	22,385	–	–	21	0·94	56	2·50	–	–	–	–	7	0·31
Sheppey	4,249	–	–	2	0·47	7	1·65	–	–	–	–	3	0·71
Strood..	15,034	–	–	6	0·40	14	0·93	4	0·27	1	0·07	3	0·20
Tenterden	5,303	–	–	–	–	7	1·32	1	0·19	–	–	3	0·57
Tonbridge	16,441	–	–	26	1·58	16	0·97	6	0·36	–	–	7	0·43
West Ashford	6,953	–	–	11	1·58	6	0·86	–	–	–	–	–	–
County of Lancaster.													
ADMINISTRATIVE COUNTY	1,620,062	45	0·03	5,101	3·15	1,527	0·94	395	0·24	92	0·06	923	0·57
COUNTY BOROUGHS:—													
Barrow in Furness ..	83,179	–	–	179	2·15	130	1·56	3	0·04	3	0·04	79	0·95
Blackburn	121,066	–	–	154	1·27	53	0·44	14	0·12	4	0·03	65	0·54
Blackpool	63,052	1	0·02	142	2·25	43	0·68	7	0·11	5	0·08	17	0·27
Bolton..	169,081	–	–	311	1·84	114	0·67	39	0·23	5	0·03	82	0·48

* The remaining part of the Urban District of Sandgate forms part of the Borough of Folkestone.

Notifications of Infectious Disease and Attack-Rates, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Lancaster —*continued.*													
County Boroughs :—													
Bootle	71,135	–	–	174	2·45	75	1·05	4	0·06	5	0·07	27	0·38
Burnley	100,183	–	–	177	1·77	96	0·96	35	0·35	2	0·02	83	0·83
Bury	53,463	1	0·02	112	2·09	48	0·90	5	0·09	2	0·04	30	0·56
*Liverpool	732,780	–	–	2,155	2·94	1,106	1·51	75	0·10	52	0·07	579	0·79
Manchester	682,608	1	0·00	1,291	1·89	639	0·94	103	0·15	114	0·17	316	0·46
Oldham	136,126	1	0·01	149	1·09	140	1·03	5	0·04	9	0·07	102	0·75
Preston	109,935	1	0·01	392	3·57	224	2·04	45	0·41	3	0·03	61	0·55
Rochdale	90,000	–	–	63	0·70	251	2·79	12	0·13	2	0·02	37	0·41
St. Helens	89,919	–	–	736	8·19	536	5·96	11	0·12	10	0·11	84	0·93
Salford	214,229	8	0·04	435	2·03	205	0·96	43	0·20	13	0·06	115	0·54
Southport	64,473	–	–	146	2·26	84	1·30	7	0·11	3	0·05	33	0·51
†Warrington	69,874	–	–	233	3·33	92	1·32	11	0·16	10	0·14	52	0·74
Wigan	83,203	–	–	820	9·86	37	0·44	85	1·02	6	0·07	59	0·71
Aggregate of Boroughs and Urban Districts.	1,397,157	45	0·03	4,436	3·18	1,310	0·94	347	0·25	81	0·06	803	0·57
Aggregate of Rural Districts.	222,905	–	–	665	2·98	217	0·97	48	0·21	11	0·05	120	0·54
Boroughs and Urban Districts :—													
Abram	6,551	3	0·46	41	6·26	6	0·92	5	0·76	–	–	5	0·76
Accrington	41,415	–	–	19	0·46	14	0·34	11	0·27	2	0·05	30	0·72
Adlington	4,293	–	–	12	2·80	–	–	1	0·23	–	–	5	1·16
Ashton in Makerfield ..	21,202	–	–	177	8·35	36	1·70	5	0·24	3	0·14	22	1·04
Ashton under Lyne ..	39,943	–	–	43	1·08	20	0·50	12	0·30	1	0·03	24	0·60
Aspull	7,542	–	–	82	10·87	6	0·80	12	1·59	–	–	3	0·40
Atherton	18,487	4	0·22	156	8·44	52	2·81	3	0·16	1	0·05	13	0·70
Audenshaw	7,511	–	–	6	0·80	4	0·53	1	0·13	–	–	2	0·27
Bacup	20,500	–	–	12	0·59	11	0·54	3	0·15	–	–	36	1·76
Barrowford	5,613	–	–	7	1·25	5	0·89	–	–	–	–	2	0·36
Billinge	4,499	–	–	6	1·33	7	1·56	1	0·22	–	–	3	0·67
Bispham with Norbreck	2,930	–	–	2	0·68	1	0·34	3	1·02	2	0·68	1	0·34
Blackrod	3,623	–	–	48	13·25	3	0·83	1	0·28	1	0·28	2	0·55
Brierfield	8,204	–	–	22	2·68	7	0·85	–	–	–	–	5	0·61
Carnforth	2,950	–	–	–	–	–	–	–	–	–	–	1	0·34
Chadderton	26,778	–	–	33	1·23	16	0·60	2	0·07	2	0·07	27	1·01
Chorley	28,192	–	–	170	6·03	12	0·43	6	0·21	1	0·04	18	0·64
Church	6,297	–	–	6	0·95	6	0·95	–	–	–	–	3	0·48
Clayton le Moors	8,428	–	–	7	0·83	5	0·59	1	0·12	1	0·12	3	0·36
Clitheroe	11,520	–	–	4	0·35	25	2·17	1	0·09	1	0·09	8	0·69
Colne	24,690	–	–	58	2·35	18	0·73	6	0·24	–	–	14	0·57
Crompton	13,778	–	–	10	0·73	4	0·29	–	–	1	0·07	19	1·38
Croston	2,019	–	–	1	0·50	3	1·49	–	–	–	–	1	0·50
Dalton in Furness ..	12,923	–	–	12	0·93	8	0·62	4	0·31	–	–	11	0·85
Darwen	37,114	–	–	54	1·45	12	0·32	5	0·13	1	0·03	19	0·51
Denton	16,731	–	–	37	2·21	7	0·42	3	0·18	–	–	9	0·54
Droylsden	12,951	–	–	19	1·47	9	0·69	3	0·23	1	0·08	10	0·77
Eccles	41,077	–	–	139	3·38	55	1·34	6	0·15	2	0·05	12	0·29
Failsworth	16,214	–	–	13	0·80	11	0·68	5	0·31	2	0·12	7	0·43
Farnworth	25,563	–	–	73	2·86	30	1·17	10	0·39	1	0·04	10	0·39
Fleetwood	14,716	–	–	5	0·34	12	0·82	–	–	1	0·07	12	0·82
Formby	5,772	–	–	12	2·08	11	1·91	–	–	–	–	–	–
Fulwood	5,591	–	–	18	3·22	5	0·89	–	–	1	0·18	1	0·18
Golborne	6,324	–	–	19	3·00	9	1·42	–	–	–	–	5	0·79
Grange	1,850	–	–	1	0·54	2	1·08	–	–	–	–	–	–
Great Crosby	13,191	–	–	36	2·73	17	1·29	5	0·38	1	0·08	13	0·99
Great Harwood	13,289	–	–	36	2·71	10	0·75	–	–	–	–	9	0·68
Haslingden	17,109	–	–	16	0·94	5	0·29	8	0·47	1	0·06	14	0·82
Haydock	9,006	–	–	92	10·22	26	2·89	5	0·56	1	0·11	10	1·11
Heysham	3,328	–	–	3	0·90	–	–	–	–	–	–	1	0·30
Heywood	24,997	1	0·04	53	2·12	28	1·12	2	0·08	5	0·20	12	0·48
Hindley	22,764	23	1·01	324	14·23	42	1·85	7	0·31	4	0·18	8	0·35
Horwich	15,520	–	–	110	7·09	6	0·39	3	0·19	2	0·13	7	0·45
Hurst	7,547	–	–	11	1·46	1	0·13	4	0·53	–	–	4	0·53

* 2 cases of Typhus Fever were notified

† 1 case of Typhus Fever was notified,

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Lancaster —*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Huyton with Roby ..	4,608	–	–	12	2·60	–	–	1	0·22	–	–	1	0·22
Ince in Makerfield ..	21,023	1	0·05	145	6·90	11	0·52	4	0·19	1	0·05	7	0·33
Irlam	8,487	–	–	10	1·18	11	1·30	2	0·24	1	0·12	10	1·18
Kearsley	9,401	–	–	8	0·85	4	0·43	5	0·53	–	–	5	0·53
Kirkham	3,566	–	–	28	7·85	15	4·21	3	0·84	1	0·28	–	–
Lancaster	33,964	–	–	150	4·42	18	0·53	5	0·15	5	0·15	18	0·53
Lathom and Burscough..	7,348	–	–	40	5·44	13	1·77	1	0·14	–	–	2	0·27
Lees	4,405	–	–	6	1·36	10	2·27	–	–	–	–	–	–
Leigh	42,686	1	0·02	225	5·27	21	0·49	7	0·16	4	0·09	42	0·98
Leyland	8,645	–	–	13	1·50	6	0·69	1	0·12	–	–	6	0·69
Litherland	15,592	–	–	68	4·36	13	0·83	1	0·06	–	–	5	0·32
Littleborough	11,426	–	–	–	–	4	0·35	–	–	1	0·09	1	0·09
Little Crosby	947	–	–	2	2·11	1	1·06	1	1·06	–	–	1	1·06
Little Hulton	7,675	–	–	19	2·48	23	3·00	2	0·26	–	–	3	0·39
Little Lever	4,756	–	–	8	1·68	11	2·31	6	1·26	1	0·21	4	0·84
Longridge	4,111	–	–	25	6·08	3	0·73	–	–	1	0·24	–	–
Lytham	8,768	–	–	4	0·46	2	0·23	1	0·11	–	–	–	–
Middleton	27,075	–	–	65	2·40	46	1·70	3	0·11	2	0·07	14	0·52
Milnrow	8,109	–	–	2	0·25	2	0·25	1	0·12	–	–	2	0·25
Morecambe	12,642	–	–	7	0·55	1	0·08	–	–	1	0·08	10	0·79
Mossley	11,973	3	0·25	26	2·17	1	0·08	1	0·08	–	–	1	0·08
Nelson	39,458	–	–	87	2·20	49	1·24	4	0·10	–	–	13	0·33
Newton in Makerfield ..	17,352	–	–	98	5·65	28	1·61	3	0·17	2	0·12	18	1·04
Norden	3,904	–	–	1	0·26	1	0·26	–	–	–	–	3	0·77
Ormskirk	6,583	–	–	12	1·82	9	1·37	–	–	1	0·15	4	0·61
Orrell	6,779	–	–	29	4·28	2	0·30	3	0·44	1	0·15	7	1·03
Oswaldtwistle	14,858	–	–	9	0·61	18	1·21	13	0·87	1	0·07	5	0·34
Padiham	11,760	–	–	22	1·87	16	1·36	1	0·09	3	0·26	5	0·43
Poulton le Fylde .. .	2,457	–	–	21	8·55	1	0·41	–	–	–	–	–	–
Preesall	1,626	–	–	17	10·46	2	1·23	–	–	–	–	1	0·62
Prescot	8,106	–	–	19	2·34	5	0·62	2	0·25	–	–	6	0·74
Prestwich	14,347	1	0·07	38	2·65	51	3·55	4	0·28	2	0·14	3	0·21
Radcliffe	23,880	2	0·08	58	2·43	24	1·01	–	–	1	0·04	16	0·67
Rainford	3,199	–	–	2	0·63	2	0·63	1	0·31	–	–	4	1·25
Ramsbottom	14,649	–	–	46	3·14	12	0·82	2	0·14	–	–	4	0·27
Rawtenstall..	28,328	–	–	15	0·53	4	0·14	13	0·46	2	0·07	12	0·42
Rishton	7,026	–	–	8	1·14	–	–	2	0·28	–	–	9	1·28
Royton	16,119	–	–	13	0·81	6	0·37	1	0·06	2	0·12	7	0·43
St. Anne's on the Sea .	9,693	–	–	14	1·44	12	1·24	1	0·10	–	–	4	0·41
Skelmersdale	6,486	–	–	49	7·55	1	0·15	6	0·93	–	–	6	0·93
Standish with Langtree	7,046	–	–	61	8·66	5	0·71	32	4·54	–	–	11	1·56
Stretford	43,502	–	–	88	2·02	49	1·13	9	0·21	2	0·05	11	0·25
Swinton and Pendlebury	29,834	1	0·03	205	6·87	21	0·70	7	0·23	–	–	30	1·01
Thornton	4,830	–	–	4	0·83	–	–	–	–	–	–	–	–
Tottington	6,441	–	–	15	2·33	1	0·16	6	0·93	–	–	–	–
Trawden	2,826	–	–	–	–	4	1·42	–	–	–	–	1	0·35
Turton	11,853	–	–	12	1·01	4	0·34	2	0·17	–	–	1	0·08
Tyldesley with Shakerley	14,797	–	–	32	2·16	20	1·35	9	0·61	–	–	11	0·74
Ulverston	9,654	–	–	6	0·62	3	0·31	–	–	–	–	6	0·62
Upholland	5,120	–	–	12	2·34	–	–	9	1·76	–	–	1	0·20
Urmston	7,784	–	–	6	0·77	16	2·06	–	–	–	–	2	0·26
Walton le Dale	11,635	–	–	52	4·47	4	0·34	8	0·69	–	–	5	0·43
Wardle	3,810	–	–	–	–	1	0·26	–	–	1	0·26	–	–
Waterloo with Seaforth	27,421	–	–	95	3·46	43	1·57	2	0·07	–	–	16	0·58
Westhoughton	14,891	1	0·07	126	8·46	15	1·01	10	0·67	2	0·13	9	0·60
Whitefield	6,660	4	0·60	13	1·95	8	1·20	–	–	–	–	1	0·15
Whitworth	8,030	–	–	41	5·11	6	0·75	5	0·62	–	–	5	0·62
Widnes	30,318	–	–	215	7·09	52	1·72	2	0·07	3	0·10	10	0·33
Withnell	3,146	–	–	5	1·59	1	0·32	–	–	–	–	–	–
Worsley	13,200	–	–	22	1·67	31	2·35	1	0·08	1	0·08	3	0·23
RURAL DISTRICTS :—													
Barton upon Irwell ..	9,495	–	–	61	6·42	5	0·53	–	–	1	0·16	12	1·26
Blackburn	8,549	–	–	2	0·23	6	0·70	1	0·12	–	–	5	0·58
Burnley	18,792	–	–	39	2·08	11	0·59	6	0·32	–	–	15	0·80
Bury	8,960	–	–	18	2·01	5	0·56	1	0·11	–	–	3	0·33
Chorley	21,269	–	–	58	2·73	12	0·56	2	0·09	–	–	9	0·42
Clitheroe	6,315	–	–	12	1·90	4	0·63	–	–	1	0·16	1	0·16

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Lancaster —*continued.*													
RURAL DISTRICTS :—													
Fylde	11,153	–	–	48	4·30	21	1·88	5	0·45	2	0·18	5	0·45
Garstang	10,058	–	–	3	0·30	5	0·50	1	0·10	–	–	1	0·10
Lancaster	8,511	–	–	9	1·06	–	–	1	0·12	1	0·12	1	0·12
Leigh	10,115	–	–	13	1·29	11	1·09	1	0·10	–	–	16	1·58
Limehurst	8,737	–	–	12	1·37	4	0·46	1	0·11	–	–	5	0·57
Lunesdale	6,335	–	–	21	3·31	–	–	3	0·47	–	–	1	0·16
Preston	18,170	–	–	87	4·79	20	1·10	6	0·33	–	–	8	0·44
Sefton..	5,135	–	–	17	3·31	6	1·17	–	–	–	–	4	0·78
Ulverston	16,483	–	–	61	3·70	10	0·61	1	0·06	1	0·06	3	0·18
Warrington	10,597	–	–	33	3·11	4	0·38	3	0·28	3	0·28	5	0·47
West Lancashire	19,733	–	–	47	2·38	20	1·01	7	0·35	1	0·05	10	0·51
Whiston	18,392	–	–	102	5·55	67	3·64	1	0·05	1	0·05	8	0·44
Wigan..	6,106	–	–	22	3·60	6	0·98	8	1·31	–	–	8	1·31
County of Leicester.													
ADMINISTRATIVE COUNTY	240,220	–	–	381	1·59	236	0·98	31	0·13	5	0·02	182	0·76
COUNTY BOROUGH :—													
Leicester	217,537	–	–	643	2·96	113	0·52	9	0·04	15	0·07	169	0·78
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	99,909	–	–	150	1·50	95	0·95	4	0·04	–	–	85	0·85
AGGREGATE OF RURAL DISTRICTS.	140,311	–	–	231	1·65	141	1·00	27	0·19	5	0·04	97	0·69
BOROUGHS AND URBAN DISTRICTS :—													
Ashby de la Zouch ..	4,471	–	–	3	0·67	4	0·89	–	–	–	–	1	0·22
Ashby Woulds	2,794	–	–	1	0·36	30	10·74	–	–	–	–	–	–
Coalville	19,390	–	–	36	1·86	7	0·36	–	–	–	–	9	0·46
Hinckley	12,886	–	–	3	0·23	1	0·08	–	–	–	–	13	1·01
Loughborough	23,113	–	–	20	0·87	4	0·17	3	0·13	–	–	39	1·69
Market Harborough ..	8,422	–	–	6	0·71	4	0·47	–	–	–	–	5	0·59
Melton Mowbray	8,255	–	–	53	6·42	35	4·24	1	0·12	–	–	4	0·48
Oadby..	2,846	–	–	2	0·70	1	0·35	–	–	–	–	–	–
Quorndon	2,351	–	–	1	0·43	–	–	–	–	–	–	2	0·85
Shepshed	5,223	–	–	13	2·49	2	0·38	–	–	–	–	3	0·57
Thurmaston	1,950	–	–	1	0·51	–	–	–	–	–	–	2	1·03
Wigston Magna	8,208	–	–	11	1·34	7	0·85	–	–	–	–	7	0·85
RURAL DISTRICTS :—													
Ashby de la Zouch ..	15,737	–	–	27	1·72	29	1·84	3	0·19	–	–	9	0·57
Barrow upon Soar ..	23,102	–	–	15	0·65	9	0·39	1	0·04	3	0·13	22	0·95
Belvoir	3,044	–	–	–	–	–	–	2	0·66	–	–	–	–
Billesdon	5,899	–	–	6	1·02	–	–	–	–	–	–	4	0·68
Blaby	15,309	–	–	60	3·92	33	2·16	4	0·26	1	0·07	18	1·18
Castle Donington	5,778	–	–	–	–	11	1·90	–	–	–	–	4	0·69
Hallaton	1,720	–	–	–	–	2	1·16	–	–	–	–	1	0·58
Hinckley	13,850	–	–	13	0·94	19	1·37	9	0·65	–	–	15	1·08
Loughborough	4,080	–	–	3	0·74	–	–	–	–	–	–	1	0·25
Lutterworth	9,514	–	–	19	2·00	5	0·53	–	–	–	–	4	0·42
Market Bosworth.. ..	20,936	–	–	20	0·96	8	0·38	2	0·10	1	0·05	7	0·33
Market Harborough ..	7,098	–	–	24	3·38	6	0·85	1	0·14	–	–	2	0·28
Melton Mowbray	14,244	–	–	44	3·09	19	1·33	5	0·35	–	–	10	0·70
County of Lincoln, Parts of Holland.													
ADMINISTRATIVE COUNTY	78,466	–	–	146	1·86	56	0·71	9	0·11	2	0·03	23	0·29
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	34,583	–	–	73	2·11	17	0·49	5	0·14	–	–	15	0·43
AGGREGATE OF RURAL DISTRICTS.	43,883	–	–	73	1·66	39	0·89	4	0·09	2	0·05	8	0·18
BOROUGHS AND URBAN DISTRICTS :—													
Boston	14,877	–	–	39	2·62	14	0·94	4	0·27	–	–	8	0·54
Holbeach	4,896	–	–	15	3·06	1	0·20	1	0·20	–	–	2	0·41
Long Sutton	2,791	–	–	2	0·72	1	0·36	–	–	–	–	1	0·36
Spalding	9,953	–	–	15	1·51	1	0·10	–	–	–	–	3	0·30
Sutton Bridge	2,066	–	–	2	0·97	–	–	–	–	–	–	1	0·48

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Lincoln, Parts of Holland—*continued.*													
RURAL DISTRICTS :—													
Boston	20,308	–	–	28	1·38	26	1·28	3	0·15	1	0·05	4	0·20
Crowland	2,583	–	–	6	2·32	–	–	–	–	1	0·39	–	–
East Elloe	8,429	–	–	2	0·24	–	–	1	0·12	–	–	4	0·47
Spalding	12,563	–	–	37	2·95	13	1·03	–	–	–	–	–	–
County of Lincoln, Parts of Kesteven.													
ADMINISTRATIVE COUNTY	104,882	–	–	193	1·84	92	0·88	4	0·04	7	0·07	42	0·40
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	40,912	–	–	60	1·47	53	1·30	1	0·02	1	0·02	23	0·56
AGGREGATE OF RURAL DISTRICTS.	63,970	–	–	133	2·08	39	0·61	3	0·05	6	0·09	19	0·30
BOROUGHS AND URBAN DISTRICTS :—													
Bourne	4,044	–	–	3	0·74	2	0·49	–	–	–	–	1	0·25
Bracebridge.. ..	2,262	–	–	5	2·21	10	4·42	–	–	–	–	2	0·88
Grantham	19,042	–	–	34	1·79	28	1·47	1	0·05	–	–	11	0·58
Ruskington	1,129	–	–	–	–	–	–	–	–	–	–	–	–
Sleaford	5,689	–	–	16	2·81	–	–	–	–	–	–	6	1·05
Stamford	8,746	–	–	2	0·23	13	1·49	–	–	1	0·11	3	0·34
RURAL DISTRICTS :—													
Bourne	12,399	–	–	13	1·05	6	0·48	–	–	2	0·16	2	0·16
Branston	14,668	–	–	48	3·27	13	0·89	1	0·07	1	0·07	8	0·55
Claypole	7,382	–	–	16	2·17	1	0·14	–	–	1	0·14	1	0·14
Grantham	11,967	–	–	11	0·92	9	0·75	–	–	–	–	5	0·42
Sleaford	16,095	–	–	43	2·67	5	0·31	1	0·06	2	0·12	3	0·19
Uffington	1,459	–	–	2	1·37	5	3·43	1	0·69	–	–	–	–
County of Lincoln, Parts of Lindsey.													
ADMINISTRATIVE COUNTY	227,397	–	–	342	1·50	374	1·64	22	0·10	10	0·04	114	0·50
COUNTY BOROUGHS :—													
Grimsby	69,959	–	–	149	2·13	108	1·54	9	0·13	–	–	14	0·20
Lincoln	55,078	–	–	145	2·63	76	1·38	2	0·04	1	0·02	42	0·76
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	92,995	–	–	144	1·55	230	2·47	10	0·11	4	0·04	68	0·73
AGGREGATE OF RURAL DISTRICTS.	134,402	–	–	198	1·47	144	1·07	12	0·09	6	0·04	46	0·34
BOROUGHS AND URBAN DISTRICTS :—													
Alford..	2,047	–	–	3	1·47	5	2·44	–	–	1	0·49	4	1·95
Barton upon Humber ..	6,174	–	–	5	0·81	2	0·32	–	–	–	–	5	0·81
Brigg	3,060	–	–	–	–	2	0·65	1	0·33	–	–	–	–
Broughton	1,500	–	–	–	–	–	–	–	–	–	–	3	2·00
Brumby and Frodingham	3,423	–	–	4	1·17	44	12·85	–	–	–	–	2	0·58
Cleethorpe with Thrunscoe.	22,810	–	–	35	1·53	33	1·45	3	0·13	1	0·04	12	0·53
Crowle	2,653	–	–	1	0·38	–	–	–	–	–	–	–	–
Gainsborough	18,351	–	–	58	3·16	10	0·54	1	0·05	1	0·05	14	0·76
Horncastle	3,378	–	–	4	1·18	1	0·30	–	–	–	–	–	–
Louth	8,955	–	–	18	2·01	11	1·23	3	0·34	1	0·11	14	1·56
Mablethorpe	1,364	–	–	–	–	–	–	–	–	–	–	2	1·47
Market Rasen	2,028	–	–	–	–	–	–	–	–	–	–	–	–
Roxby cum Risby ..	500	–	–	1	2·00	–	–	–	–	–	–	–	–
Scunthorpe	10,499	–	–	8	0·76	120	11·43	1	0·10	–	–	7	0·67
Skegness	3,324	–	–	3	0·90	2	0·60	1	0·30	–	–	5	1·50
Winterton	1,448	–	–	1	0·69	–	–	–	–	–	–	–	–
Woodhall Spa	1,481	–	–	3	2·03	–	–	–	–	–	–	–	–

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Lincoln, Parts of Lindsey—*continued.*													
RURAL DISTRICTS:—													
Caistor	12,132	–	–	28	2·31	–	–	2	0·16	1	0·08	–	–
Gainsborough	13,565	–	–	21	1·55	12	0·88	1	0·07	–	–	6	0·44
Glanford Brigg	31,034	–	–	26	0·84	85	2·74	5	0·16	4	0·13	18	0·58
Grimsby	10,078	–	–	10	0·99	20	1·98	1	0·10	–	–	2	0·20
Horncastle	12,120	–	–	57	4·70	12	0·99	–	–	–	–	2	0·17
Isle of Axholme	6,056	–	–	5	0·83	1	0·17	1	0·17	–	–	–	–
Louth	16,908	–	–	15	0·89	3	0·18	–	–	–	–	5	0·30
Sibsey	2,809	–	–	4	1·42	2	0·71	–	–	–	–	–	–
Spilsby	19,208	–	–	30	1·56	6	0·31	1	0·05	–	–	13	0·68
Welton	10,492	–	–	2	0·19	3	0·29	1	0·10	1	0·10	–	–
County of Middlesex.													
ADMINISTRATIVE COUNTY	1,169,806	–	–	2,282	1·95	1,796	1·54	114	0·10	72	0·06	560	0·48
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	1,120,482	–	–	2,199	1·96	1,615	1·44	106	0·09	72	0·06	540	0·48
AGGREGATE OF RURAL DISTRICTS.	49,324	–	–	83	1·68	181	3·67	8	0·16	–	–	20	0·41
BOROUGHS AND URBAN DISTRICTS:—													
Acton	57,913	–	–	63	1·09	70	1·21	4	0·07	4	0·07	29	0·50
Brentford	15,587	–	–	36	2·31	10	0·64	4	0·26	2	0·13	3	0·19
Chiswick	37,908	–	–	34	0·90	35	0·92	1	0·03	4	0·11	25	0·66
Ealing..	65,566	–	–	150	2·29	35	0·53	5	0·08	1	0·02	21	0·32
Edmonton	66,800	–	–	114	1·71	87	1·30	6	0·09	25	0·37	63	0·94
Enfield	59,817	–	–	128	2·14	60	1·00	4	0·07	1	0·02	33	0·55
Feltham	4,986	–	–	8	1·60	18	3·61	–	–	–	–	5	1·00
Finchley	43,607	–	–	86	1·97	64	1·47	6	0·14	2	0·05	18	0·41
Friern Barnet	12,889	–	–	15	1·16	26	2·02	6	0·47	–	–	8	0·62
Greenford	1,168	–	–	1	0·86	–	–	–	–	–	–	1	0·86
Hampton	9,022	–	–	20	2·22	12	1·33	–	–	–		7	0·78
Hampton Wick	2,401	–	–	2	0·83	12	5·00	–	–	–	–	–	–
Hanwell	19,973	–	–	55	2·75	58	2·90	–	–	–	–	10	0·50
Harrow on the Hill ..	17,128	–	–	32	1·87	34	1·99	–	–	–	–	3	0·18
Hayes	4,929	–	–	7	1·42	6	1·22	–	–	–	–	1	0·20
Hendon	52,915	–	–	41	0·77	56	1·06	11	0·21	2	0·04	18	0·34
Heston and Isleworth ..	40,770	–	–	74	1·82	48	1·18	2	0·05	7	0·17	21	0·52
Hornsey	80,547	–	–	104	1·29	80	0·99	7	0·09	1	0·01	30	0·37
Kingsbury	891	–	–	–	–	–	–	–	–	–	–	1	1·12
Ruislip Northwood ..	7,288	–	–	37	5·08	16	2·20	–	–	3	0·41	6	0·82
Southall Norwood ..	25,584	–	–	76	2·97	54	2·11	17	0·66	–	–	22	0·86
Southgate	37,414	–	–	52	1·39	70	1·87	9	0·24	–	–	9	0·24
Staines	6,462	–	–	7	1·08	5	0·77	–	–	–	–	1	0·15
Sunbury on Thames ..	4,643	–	–	3	0·65	8	1·72	–	–	–	–	3	0·65
Teddington	18,436	–	–	23	1·25	5	0·27	–	–	–	–	7	0·38
Tottenham	142,944	–	–	386	2·70	351	2·46	6	0·04	7	0·05	59	0.41
Twickenham	33,229	–	–	44	1·32	42	1·26	5	0·15	–	–	9	0·27
Uxbridge	10,095	–	–	6	0·59	16	1·58	–	–	–	–	5	0·50
Wealdstone	12,367	–	–	8	0·65	13	1·05	–	–	–	–	8	0·65
Wembley	14,611	–	–	49	3·35	8	0·55	2	0·14	1	0·07	5	0·34
Willesden	158,218	–	–	388	2·45	226	1·43	3	0·02	11	0·07	87	0·55
Wood Green	50,027	–	–	124	2·48	83	1·66	6	0·12	–	–	21	0·42
Yiewsley	4,347	–	–	26	5·98	7	1·61	2	0·46	1	0·23	1	0·23
RURAL DISTRICTS:—													
Hendon	16,176	–	–	21	1·30	20	1·24	6	0·37	–	–	4	0·25
South Mimms	2,744	–	–	1	0·36	2	0·73	–	–	–	–	–	–
Staines	21,434	–	–	40	1·87	149	6·95	2	0·09	–	–	16	0·75
Uxbridge	8,970	–	–	21	2·34	10	1·11	–	–	–	–	–	–

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Norfolk.													
ADMINISTRATIVE COUNTY	291,662	–	–	348	1·19	272	0·93	90	0·31	10	0·03	86	0·29
COUNTY BOROUGHS :—													
Great Yarmouth	47,514	–	–	52	1·09	92	1·94	24	0·51	–	–	35	0·74
Norwich	112,901	–	–	228	2·02	253	2·24	23	0·20	3	0·03	45	0·40
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	55,908	–	–	30	0·54	51	0·91	64	1·14	2	0·04	22	0·39
AGGREGATE OF RURAL DISTRICTS.	235,754	–	–	318	1·35	221	0·94	26	0·11	8	0·03	64	0·27
BOROUGHS AND URBAN DISTRICTS :—													
Cromer	3,349	–	–	–	–	1	0·30	2	0·60	–	–	3	0·90
Diss	3,467	–	–	1	0·29	–	–	1	0·29	–	–	–	–
Downham Market ..	2,143	–	–	2	0·93	–	–	–	–	–	–	1	0·47
East Dereham	5,363	–	–	4	0·75	3	0·56	–	–	–	–	–	–
King's Lynn..	18,746	–	–	13	0·69	17	0·91	8	0·43	1	0·05	4	0·21
New Hunstanton	2,262	–	–	–	–	4	1·77	–	–	–	–	–	–
North Walsham	4,022	–	–	–	–	4	0·99	–	–	1	0·25	–	–
Sheringham.. .. .	3,180	–	–	–	–	3	0·94	–	–	–	–	5	1·57
Swaffham	2,775	–	–	–	–	–	–	–	–	–	–	–	–
Thetford	4,540	–	–	8	1·76	11	2·42	1	0·22	–	–	2	0·44
Walsoken	3,721	–	–	2	0·54	7	1·88	49	13·17	–	–	3	0·81
Wells	2,340	–	–	–	–	1	0·43	3	1·28	–	–	4	1·71
RURAL DISTRICTS :—													
Aylsham	15,767	–	–	30	1·90	6	0·38	1	0·06	1	0·06	2	0·13
Blofield	10,579	–	–	7	0·66	18	1·70	1	0·09	–	–	2	0·19
Depwade	18,079	–	–	4	0·22	3	0·17	–	–	–	–	4	0·22
Docking	15,519	–	–	33	2·13	59	3·80	3	0·19	1	0·06	4	0·26
Downham	14,384	–	–	17	1·18	1	0·07	2	0·14	–	–	3	0·21
East and West Flegg ..	9,073	–	–	2	0·22	10	1·10	–	–	–	–	1	0·11
Erpingham	15,501	–	–	16	1·03	24	1·55	1	0·06	1	0·06	3	0·19
Forehoe	10,265	–	–	12	1·17	15	1·46	–	–	1	0·10	3	0·29
Freebridge Lynn	11,051	–	–	14	1·27	5	0·45	5	0·45	–	–	2	0·18
Henstead	9,505	–	–	11	1·16	53	5·58	–	–	–	–	1	0·11
King's Lynn	914	–	–	4	4·38	1	1·09	–	–	–	–	–	–
Loddon and Clavering ..	11,538	–	–	22	1·91	1	0·09	4	0·35	1	0·09	13	1·13
Marshland	12,242	–	–	15	1·23	3	0·25	2	0·16	1	0·08	1	0·08
Mitford and Launditch ..	16,305	–	–	39	2·39	–	–	1	0·06	1	0·06	7	0·43
St. Faith's	9,213	–	–	9	0·98	3	0·33	–	–	–	–	3	0·33
Smallburgh	12,508	–	–	49	3·92	7	0·56	4	0·32	1	0·08	4	0·32
Swaffham	6,908	–	–	10	1·45	–	–	–	–	–	–	–	–
Thetford	8,462	–	–	14	1·65	4	0·47	–	–	–	–	4	0·47
Walsingham	15,951	–	–	6	0·38	4	0·25	2	0·13	–	–	4	0·25
Wayland	11,990	–	–	4	0·33	4	0·33	–	–	–	–	3	0·25
County of Northampton.													
ADMINISTRATIVE COUNTY	202,552	–	–	332	1·64	489	2·41	23	0·11	8	0·04	116	0·57
COUNTY BOROUGH :—													
Northampton	86,128	–	–	259	3·01	137	1·59	8	0·09	8	0·09	66	0·77
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	93,608	–	–	107	1·14	211	2·25	12	0·13	7	0·07	50	0·53
AGGREGATE OF RURAL DISTRICTS.	108,944	–	–	225	2·07	278	2·55	11	0·10	1	0·01	66	0·61
BOROUGHS AND URBAN DISTRICTS :—													
Brackley	2,103	–	–	18	8·56	9	4·28	–	–	1	0·48	–	–
Daventry	3,069	–	–	–	–	–	–	–	–	1	0·33	3	0·98
Desborough	4,124	–	–	–	–	21	5·09	2	0·48	2	0·48	1	0·24
Finedon	3,877	–	–	3	0·77	18	4·64	–	–	–	–	5	1·29
Higham Ferrers	2,769	–	–	1	0·36	1	0·36	–	–	–	–	1	0·36
Irthlingborough . ..	4,665	–	–	3	0·64	1	0·21	5	1·07	–	–	–	–
Kettering	29,524	–	–	21	0·71	35	1·19	3	0·10	2	0·07	18	0·61
Oundle	2,258	–	–	–	–	–	–	–	–	–	–	–	–
Raunds	4,005	–	–	3	0·75	1	0·25	1	0·25	–	–	4	1·00
Rothwell	4,326	–	–	3	0·69	8	1·85	–	–	–	–	3	0·69
Rushden	13,531	–	–	35	2·59	29	2·14	–	–	–	–	5	0·37
Wellingborough	19,357	–	–	20	1·03	88	4·55	1	0·05	1	0·05	10	0·52

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

———	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Northampton—*continued.*													
RURAL DISTRICTS :—													
Brackley	6,458	-	-	28	4·34	–	–	–	–	–	–	–	–
Brixworth	10,901	–	–	13	1·19	44	4·04	2	0·18	–	–	13	1·19
Crick	2,315	–	–	15	6·48	4	1·73	–	–	–	–	–	–
Daventry	12,762	–	–	73	5·72	45	3·53	–	–	–	–	9	0·71
Easton on the Hill ..	1,378	–	–	–	–	–	–	-	–	–	–	–	–
Gretton	1,405	–	–	–	–	1	0·71	–	–	–	–	–	–
Hardingstone	7,049	-	–	9	1·28	5	0·71	4	0·57	–	–	3	0·43
Kettering	12,392	–	–	18	1·45	75	6·05	1	0·08	–	–	10	0·81
Middleton Cheney ..	2,354	–	–	23	9·77	2	0·85	–	–	–	–	–	–
Northampton	5,444	–	–	6	1·10	2	0·37	1	0·18	–	–	1	0·18
*Oundle (part of)	6,266	–	–	–	–	1	0·16	–	–	1	0·16	8	1·28
Oxendon	3.970	–	–	2	0·50	7	1·76	–	–	–	–	1	0·25
Potterspury..	4,579	–	–	11	2·40	–	–	2	0·44	–	–	1	0·22
*Thrapston (part of) ..	10,173	–	–	9	0·88	13	1·28	1	0·10	–	–	4	0·39
Towcester	9,300	–	–	5	0·54	23	2·47	–	–	–	–	10	1·08
Wellingborough	12,198	–	–	13	1·07	56	4·59	–	–	–	–	6	0·49
County of Peterborough, Soke of.													
ADMINISTRATIVE COUNTY	45,374	-	-	129	2·84	33	0·73	1	0·02	–	-	15	0·33
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	34,575	–	-	113	3·27	24	0·69	1	0·03	–	–	15	0·43
AGGREGATE OF RURAL DISTRICTS.	10,799	-	-	16	1·48	9	0·83	–	–	–	–	-	–
BOROUGHS AND URBAN DISTRICTS :—													
Peterborough	34,575	–	–	113	3·27	24	0·69	1	0·03	–	–	15	0·43
RURAL DISTRICTS :—													
Barnack	1,896	–	–	3	1·58	2	1·05	–	–	–	–	–	–
Peterborough	8,903	-	-	13	1·46	7	0·79	–	–	-	–	–	–
County of Northumberland.													
ADMINISTRATIVE COUNTY	357,283	–	–	883	2·47	520	1·46	61	0·17	7	0·02	201	0·56
COUNTY BOROUGHS :—													
Newcastle upon Tyne ..	272,259†	–	-	698	2·56	265	0·97	72	0·26	22	0·08	180	0·66
Tynemouth	57,192	-	-	130	2·27	53	0·93	64	1·12	2	0·03	38	0·66
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS	263,557	–	–	679	2·58	392	1·49	55	0·21	4	0·02	150	0·57
AGGREGATE OF RURAL DISTRICTS.	93,726	–	–	204	2·18	128	1·37	6	0·06	3	0·03	51	0·54
BOROUGHS AND URBAN DISTRICTS :—													
Alnwick	6,272	–	–	3	0·48	1	0·16	–	–	–	–	2	0·32
Amble..	4,145	–	–	4	0·97	4	0·97	–	–	–	–	–	–
Ashington	25,014	–	–	136	5·44	121	4·84	9	0·36	2	0·08	30	1·20
Bedlingtonshire	23,492	–	-	22	0·94	27	1·15	8	0·34	1	0·04	11	0·47
Berwick upon Tweed ..	11,327	–	–	4	0·35	8	0·71	7	0·62	–	–	7	0·62
Blyth	28,544	–	–	38	1·33	20	0·70	5	0·18	-	–	20	0·70
Cramlington	7,366	–	–	22	2·99	1	0·14	–	–	–	–	3	0·41
Earsdon	10,137	–	–	39	3·85	34	3·35	2	0·20	-	–	5	0·49
Gosforth	14,009	–	–	42	3·00	24	1·71	2	0·14	–	–	4	0·29
Hexham	8,071	–	–	27	3·35	11	1·36	2	0·25	–	–	1	0·12
Longbenton	12,383	-	-	23	1·86	18	1·45	2	0·16	–	–	6	0·48
Morpeth	6,655	–	–	2	0·30	-	-	2	0·30	–	–	1	0·15
Newbiggin by the Sea ..	5,110	–	–	25	4·89	7	1·37	1	0·20	–	–	4	0·78

* The remaining parts of the Rural Districts of Oundle and Thrapston are in the Administrative County of Huntingdon. The figures for the entire Districts are as follows :—

Oundle	7,278	–	–	–	–	1	0·14	–		2	0·27	9	1·24
Thrapston	10,998	–	–	9	0·82	13	1·18	1	0·09	–	–	4	0·36

† Including Moot Hall and precincts.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diph-theria.		Enteric Fever.		Puerperal Fever.		Ery-sipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Northumberland—*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Newburn	17,831	–	–	55	3·08	40	2·24	7	0·39	–	–	14	0·79
Prudhoe	7,658	–	–	41	5·35	8	1·04	–	–	–	–	4	0·52
Rothbury	1,057	–	–	5	4·73	–	–	–	–	–	–	4	3·78
Seaton Delaval	6,473	–	–	20	3·09	16	2·47	–	–	–	–	4	0·62
Seghill	1,943	–	–	1	0·51	–	–	–	–	–	–	2	1·03
Wallsend	42,706	–	–	122	2·86	30	0·70	5	0·12	–	–	21	0·49
Weetslade	6,141	–	–	27	4·40	10	1·63	1	0·16	1	0·16	3	0·49
Whitley and Monkseaton	17,223	–	–	21	1·22	12	0·70	2	0·12	–	–	4	0·23
RURAL DISTRICTS :—													
Alnwick	10,859	–	–	18	1·66	19	1·75	1	0·09	2	0·18	7	0·64
Belford	4,373	–	–	3	0·69	1	0·23	–	–	–	–	3	0·69
Bellingham	5,425	–	–	10	1·84	4	0·74	–	–	–	–	3	0·55
Castle Ward..	10,718	–	–	24	2·24	8	0·75	–	–	–	–	7	0·65
Glendale	7,712	–	–	4	0·52	3	0·39	–	–	–	–	5	0·65
Haltwistle	8,850	–	–	5	0·56	6	0·68	–	–	–	–	1	0·11
Hexham	20,634	–	–	68	3·30	59	2·86	3	0·15	1	0·05	12	0·58
Morpeth	15,579	–	–	43	2·76	26	1·67	–	–	–	–	6	0·39
Norham and Islandshires.	5,297	–	–	9	1·70	1	0·19	2	0·38	–	–	1	0·19
Rothbury	4,279	–	–	20	4·67	1	0·23	–	–	–	–	6	1·40
County of Nottingham.													
ADMINISTRATIVE COUNTY	344,501	–	–	690	2·00	562	1·63	63	0·18	17	0·05	209	0·61
COUNTY BOROUGH :— Nottingham..	235,613	–	–	420	1·78	195	0 83	58	0·25	12	0·05	204	0·87
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	222,169	–	–	507	2·28	362	1·63	40	0·18	12	0·05	144	0·65
AGGREGATE OF RURAL DISTRICTS.	122,332	–	–	183	1·50	200	1·63	23	0·19	5	0·04	65	0·53
BOROUGHS AND URBAN DISTRICTS :—													
Arnold	11,007	–	–	9	0·82	2	0·18	–	–	–	–	5	0·45
Beeston	11,530	–	–	10	0·87	12	1·04	2	0·17	1	0·09	5	0·43
Carlton	16,539	–	–	28	1·69	10	0·60	6	0·36	1	0·06	22	1·33
East Retford	12,320	–	–	44	3·57	9	0·73	–	–	1	0·08	22	1·79
Eastwood	4,685	–	–	2	0·43	2	0·43	–	–	–	–	4	0·85
Hucknall Torkard ..	15,207	–	–	28	1·84	14	0·92	–	–	–	–	10	0·66
Huthwaite	5,288	–	–	10	1·89	6	1·13	–	–	–	–	–	–
Kirkby in Ashfield ..	16,153	–	–	30	1·86	16	0·99	3	0·19	–	–	9	0·56
Mansfield	40,319	–	–	137	3·40	129	3·20	7	0·17	5	0·12	32	0·79
Mansfield Woodhouse ..	12,182	–	–	53	4·35	26	2·13	1	0·08	1	0·08	9	0·74
Newark	15,322	–	–	7	0·46	66	4·31	–	–	–	–	3	0·20
Sutton in Ashfield ..	22,856	–	–	42	1·84	25	1·09	18	0·79	1	0·04	10	0·44
Warsop	5,564	–	–	18	3·24	21	3·77	2	0·36	2	0·36	2	0·36
West Bridgford	12,981	–	–	11	0·85	11	0·85	–	–	–	–	8	0·62
Worksop	20,216	–	–	78	3·86	13	0·64	1	0·05	–	–	3	0·15
RURAL DISTRICTS :—													
Basford	40,648	–	–	53	1·30	106	2·61	5	0·12	1	0·02	22	0·54
Bingham	13,033	–	–	21	1·61	19	1·46	12	0·92	–	–	10	0·77
Blyth and Cuckney ..	4,463	–	–	28	6·27	1	0·22	–	–	–	–	1	0·22
East Retford	13,336	–	–	28	2·10	4	0·30	1	0·07	–	–	4	0·30
*Kingston and Ratcliffe on Soar (parishes).	381	–	–	1	2·62	–	–	–	–	–	–	–	–
Leake	3,460	–	–	1	0·29	2	0·58	2	0·58	–	–	–	–
Misterton	3,870	–	–	1	0·26	1	0·26	1	0·26	1	0·26	–	–
Newark	7,771	–	–	9	1·16	26	3·35	–	–	–	–	–	–
Skegby	7,640	–	–	22	2·88	3	0·39	–	–	–	–	5	0·65
Southwell	18,155	–	–	17	0·94	37	2·04	1	0·06	3	0·17	9	0·50
Stapleford	9,575	–	–	2	0·21	1	0·10	1	0·10	–	–	14	1·46

* These Parishes are administered by the Rural District Council of Shardlow (Derbyshire).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Oxford.													
ADMINISTRATIVE COUNTY	121,227	–	–	197	1·63	89	0·73	6	0·05	4	0·03	75	0·62
COUNTY BOROUGH :— Oxford	47,446	–	–	27	0·57	31	0·65	5	0·11	–	–	15	0·32
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	31,904	–	–	54	1·69	13	0·41	2	0·06	2	0·06	28	0·88
AGGREGATE OF RURAL DISTRICTS.	89,323	–	–	143	1·60	76	0·85	4	0·04	2	0·02	47	0·53
BOROUGHS AND URBAN DISTRICTS :—													
Banbury	11,894	–	–	20	1·68	5	0·42	1	0·08	2	0·17	7	0·59
Bicester	2,870	–	–	15	5·23	–	–	–	–	–	–	2	0·70
Chipping Norton	3,240	–	–	2	0·62	2	0·62	–	–	–	–	11	3·40
Henley upon Thames ..	6,002	–	–	7	1·17	3	0·50	–	–	–	–	2	0·33
Thame	2,551	–	–	–	–	–	–	1	0·39	–	–	3	1·18
Wheatley	864	–	–	3	3·47	–	–	–	–	–	–	–	–
Witney	3,216	–	–	7	2·18	–	–	–	–	–	–	3	0·93
Woodstock	1,267	–	–	–	–	3	2·37	–	–	–	–	–	–
RURAL DISTRICTS :—													
Banbury	10,340	–	–	55	5·32	7	0·68	1	0·10	–	–	6	0·58
Bicester	8,210	–	–	52	6·33	5	0·61	1	0·12	–	–	9	1·10
Chipping Norton	10,270	–	–	7	0·68	3	0·29	–	–	–	–	7	0·68
Crowmarsh	4,573	–	–	–	–	1	0·22	–	–	–	–	–	–
Culham	2,333	–	–	1	0·43	11	4·71	1	0·43	–	–	–	–
Goring	2,788	–	–	–	–	11	3·95	–	–	–	–	–	–
Headington	11,705	–	–	3	0·26	7	0·60	–	–	–	–	3	0·26
Henley	9,170	–	–	4	0·44	3	0·33	–	–	1	0·11	2	0·22
Thame	4,876	–	–	7	1·44	–	–	–	–	1	0·21	2	0·41
Witney	15,220	–	–	6	0·39	25	1·64	1	0·07	–	–	12	0·79
Woodstock	9,838	–	–	8	0·81	3	0·30	–	–	–	–	6	0·61
County of Rutland.													
ADMINISTRATIVE COUNTY	17,433	–	–	10	0·57	15	0·86	–	–	–	–	4	0·23
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	3,133	–	–	2	0·64	2	0·64	–	–	–	–	–	–
AGGREGATE OF RURAL DISTRICTS.	14,300	–	–	8	0·56	13	0·91	–	–	–	–	4	0·28
BOROUGHS AND URBAN DISTRICTS :—													
Oakham	3,133	–	–	2	0·64	2	0·64	–	–	–	–	–	–
RURAL DISTRICTS :—													
Ketton	2,593	–	–	–	–	3	1·16	–	–	–	–	–	–
Oakham	6,082	–	–	3	0·49	1	0·16	–	–	–	–	4	0·66
Uppingham	5,625	–	–	5	0·89	9	1·60	–	–	–	–	–	–
County of Salop.													
ADMINISTRATIVE COUNTY	226,503	–	–	378	1·67	331	1·46	7	0·03	8	0·04	74	0·33
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	104,647	–	–	202	1·93	195	1·86	2	0·02	3	0·03	34	0·32
AGGREGATE OF RURAL DISTRICTS.	121,856	–	–	176	1·44	136	1·12	5	0·04	5	0·04	40	0·33
BOROUGHS AND URBAN DISTRICTS :—													
Bishop's Castle ..	1,232	–	–	11	8·93	–	–	–	–	–	–	–	–
Bridgnorth	5,054	–	–	3	0·59	1	0·20	–	–	–	–	–	–
Church Stretton	1,253	–	–	–	–	1	0·80	–	–	–	–	–	–
Dawley	7,074	–	–	8	1·13	1	0·14	–	–	1	0·14	3	0·42

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Salop—*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Ellesmere	1,751	–	–	4	2·28	–	–	–	–	–	–	–	–
Ludlow	5,270	–	–	23	4·36	3	0·57	1	0·19	1	0·19	3	0·57
Market Drayton	4,349	–	–	11	2·53	1	0·23	–	–	–	–	1	0·23
Newport	2,844	–	–	3	1·05	1	0·35	–	–	–	–	1	0·35
Oakengates	10,871	–	–	16	1·47	12	1·10	–	–	1	0·09	6	0·55
Oswestry	9,662	–	–	26	2·69	28	2·90	–	–	–	–	5	0·52
Shrewsbury	27,756	–	–	83	2·99	99	3·57	1	0·04	–	–	6	0·22
Wellington	7,028	–	–	1	0·14	8	1·14	–	–	–	–	2	0·28
Wem	2,032	–	–	6	2·95	–	–	–	–	–	–	–	–
Wenlock	12,910	–	–	–	–	37	2·87	–	–	–	–	5	0·39
Whitchurch	5,561	–	–	7	1·26	3	0·54	–	–	–	–	2	0·36
RURAL DISTRICTS :—													
Atcham	19,330	–	–	47	2·43	50	2·59	1	0·05	–	–	9	0·47
Bridgnorth	8,393	–	–	3	0·36	1	0·12	1	0·12	1	0·12	3	0·36
Burford	1,129	–	–	2	1·77	6	5·31	–	–	1	0·89	–	–
Chirbury	2,928	–	–	3	1·02	1	0·34	–	–	–	–	–	–
Church Stretton	4,405	–	–	1	0·23	6	1·36	–	–	–	–	1	0·23
Cleobury Mortimer	6,751	–	–	13	1·93	2	0·30	1	0·15	–	–	2	0·30
Clun	6,070	–	–	–	–	25	4·12	1	0·16	–	–	1	0·16
Drayton	6,848	–	–	22	3·21	–	–	–	–	–	–	1	0·15
Ellesmere	7,693	–	–	9	1·17	5	0·65	–	–	–	–	–	–
Ludlow	8,887	–	–	7	0·79	–	–	–	–	1	0·11	2	0·23
Newport	5,317	–	–	6	1·13	4	0·75	–	–	–	–	2	0·38
Oswestry	14,358	–	–	30	2·09	23	1·60	–	–	1	0·07	9	0·63
Shifnal	7,765	–	–	10	1·29	7	0·90	–	–	–	–	1	0·13
Teme	1,509	–	–	–	–	–	–	–	–	–	–	1	0·66
Wellington	10,533	–	–	5	0·47	2	0·19	1	0·09	–	–	6	0·57
Wem	8,020	–	–	15	1·87	2	0·25	–	–	1	0·12	–	–
Whitchurch	1,920	–	–	3	1·56	2	1·04	–	–	–	–	2	1·04
County of Somerset.													
ADMINISTRATIVE COUNTY	355,749	–	–	518	1·46	386	1·09	75	0·21	8	0·02	124	0·35
COUNTY BOROUGH :— Bath	61,831	–	–	125	2·02	140	2·26	10	0·16	2	0·03	48	0·78
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	146,526	–	–	262	1·79	144	0·98	54	0·37	1	0·01	38	0·26
AGGREGATE OF RURAL DISTRICTS.	209,223	–	–	256	1·22	242	1·16	21	0·10	7	0.03	86	0·41
BOROUGHS AND URBAN DISTRICTS :—													
Bridgwater	14,643	–	–	20	1·37	5	0·34	1	0·07	–	–	3	0·20
Burnham	4,128	–	–	29	7·03	1	0·24	–	–	–	–	–	–
Chard	4,002	–	–	–	–	2	0·50	47	11·74	–	–	–	–
Clevedon	5,422	–	–	6	1·11	4	0·74	–	–	–	–	2	0·37
Crewkerne	3,713	–	–	5	1·35	13	3·50	–	–	–	–	–	–
Frome	9,924	–	–	6	0·60	–	–	–	–	–	–	2	0·20
Glastonbury	3,769	–	–	9	2·39	–	–	–	–	–	–	3	0·80
Highbridge	2,164	–	–	2	0.92	–	–	–	–	–	–	–	–
Ilminster	2,323	–	–	3	1·29	–	–	–	–	–	–	2	0·86
Midsomer Norton	7,426	–	–	9	1·21	6	0·81	–	–	–	–	3	0·40
*Minehead	4,585	–	–	10	2·30	–	–	–	–	–	–	–	–
Portishead	3,446	–	–	3	0·87	–	–	–	–	–	–	–	–
Radstock	3,490	–	–	–	–	4	1·15	–	–	–	–	4	1·15
Shepton Mallet	3,974	–	–	10	2·52	1	0·25	–	–	–	–	–	–
Street	3,879	–	–	18	4·64	9	2·32	–	–	–	–	–	–
Taunton	20,585	–	–	35	1·70	56	2·72	1	0·05	1	0·05	3	0·15
Watchet	1,608	–	–	–	–	–	–	–	–	–	–	1	0·62
Wellington	7,046	–	–	25	3·55	3	0·43	1	0·14	–	–	2	0·28
Wells	4,116	–	–	6	1·46	1	0·24	1	0·24	–	–	1	0.24
Weston super Mare	21,715	–	–	44	2·03	30	1·38	2	0·09	–	–	6	0·28
Wiveliscombe	1,249	–	–	–	–	–	–	–	–	–	–	–	–
Yeovil	13,319	–	–	22	1·65	9	0·68	1	0·08	–	–	6	0·45
RURAL DISTRICTS :—													
Axbridge	20,847	–	–	23	1·10	36	1·73	4	0·19	1	0·05	19	0·91
Bath	13,604	–	–	29	2·13	26	1·91	–	–	–	–	4	0·29
Bridgwater	16,539	–	–	12	0·73	3	0·18	1	0·06	–	–	1	0·06

* On 1st April, 1916, the Urban District of Minehead was extended so as to include portions of the Rural District of Williton. Allowance has been made in the calculation of rates.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Somerset—*continued.*													
RURAL DISTRICTS:—													
Chard..	12,256	–	–	1	0·08	8	0·65	2	0·16	–	–	6	0·49
Clutton	14,825	–	–	6	0·40	36	2·43	–	–	1	0·07	11	0·74
Dulverton	4,248	–	–	4	0·94	–	–	–	–	–	–	3	0·71
Frome..	10,569	–	–	19	1·80	5	0·47	–	–	1	0·09	–	–
Keynsham	9,620	–	–	21	2·18	5	0·52	1	0·10	1	0·10	1	0·10
Langport	11,767	–	–	10	0·85	10	0·85	1	0·08	–	–	3	0·25
Long Ashton	15,556	–	–	34	2·19	22	1·41	–	–	–	–	9	0·58
Shepton Mallet .. .	9,486	–	–	15	1·58	20	2·11	–	–	–	–	1	0·11
Taunton	15,431	–	–	14	0·91	18	1·17	6	0·39	–	–	7	0·45
Wellington	5,575	–	–	5	0·90	2	0·36	–	–	–	–	–	–
Wells	8,490	–	–	22	2·59	9	1·06	3	0·35	–	–	6	0·71
Williton	10,620	–	–	7	0·64	14	1·29	–	–	–	–	2	0·18
Wincanton	14,493	–	–	20	1·38	20	1·38	3	0·21	2	0·14	8	0·55
Yeovil..	15,297	–	–	14	0·92	8	0·52	–	–	1	0·07	5	0·33
County of Southampton.													
ADMINISTRATIVE COUNTY	384,129	–	–	538	1·40	382	0·99	53	0·14	14	0·04	122	0·32
COUNTY BOROUGHS:—													
Bournemouth	70,715	–	–	79	1·12	101	1·43	1	0·01	4	0·06	18	0·25
Portsmouth	197,843	–	–	393	1·99	676	3·42	78	0·39	5	0·03	85	0·43
Southampton	116,391	1	0·01	188	1·62	170	1·46	23	0·20	8	0·07	47	0·40
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	178,337	-	–	302	1·69	227	1·27	32	0·18	8	0·04	51	0·29
AGGREGATE OF RURAL DISTRICTS.	205,792	–	–	236	1·15	155	0·75	21	0·10	6	0·03	71	0·35
BOROUGHS AND URBAN DISTRICTS:—													
Aldershot	21,073	-	–	29	1·38	33	1·57	1	0·05	–	–	5	0·24
Alton	5,013	–	–	6	1·20	1	0·20	–	–	–	–	3	0·60
Andover	8,095	–	–	18	2·22	6	0·74	–	–	–	–	2	0·25
Basingstoke	11,976	–	–	16	1·34	4	0·33	–	–	–	–	1	0·08
Christchurch	5,378	–	–	1	0·19	5	0·93	–	–	1	0·19	–	–
Eastleigh and Bishop-stoke.	14,418	–	–	79	5·48	12	0·83	3	0·21	–	–	9	0·62
Fareham	7,405	–	–	6	0·81	4	0·54	8	1·08	-	–	1	0·14
Farnborough	10,304	–	-	5	0·49	8	0·78	2	0·19	–	–	2	0·19
Fleet	3,412	–	–	5	1·47	6	1·76	–	–	–	–	-	-
Gosport and Alverstoke..	27,014	–	–	39	1·44	103	3·81	7	0·26	3	0·11	11	0·41
Havant	4,010	–	–	5	1·25	5	1·25	1	0·25	–	–	–	–
Itchen..	22,134	-	–	38	1·72	19	0·86	5	0·23	3	0·14	7	0·32
Lymington	4,010	–	–	–	-	–	–	-	–	–	–	–	–
Petersfield	3,612	–	–	3	0·83	2	0·55	–	–	–	–	–	–
Romsey	4,532	–	–	4	0·88	2	0·44	–	–	–	–	2	0·44
Warblington	3,692	–	-	1	0·27	6	1·63	4	1·08	-	-	1	0·27
Winchester	22,259	–	-	47	2·11	11	0·49	1	0·04	1	0·04	7	0·31
RURAL DISTRICTS:—													
Alresford	6,816	-	-	6	0·88	1	0·15	–	-	1	0·15	–	–
Alton	12,623	–	–	14	1·11	1	0·08	3	0·24	-	-	1	0·08
Andover	9,734	–	–	8	0·82	13	1·34	1	0·10	–	-	5	0·51
Basingstoke	11,732	–	–	13	1·11	1	0·09	-	-	1	0·09	2	0·17
Catherington	3,391	-	–	1	0·29	3	0·88	-	–	–	–	-	–
Christchurch	4,518	–	-	8	1·77	1	0·22	-	-	1	0·22	2	0·44
Droxford	11,898	–	-	11	0·92	10	0·84	–	–	–	–	10	0·84
Fareham	13,301	–	–	36	2·71	31	2·33	4	0·30	-	-	1	0·08
Fordingbridge	5,908	–	–	8	1·35	3	0·51	2	0·34	-	–	6	1·02
Hartley Wintney	17,518	–	–	19	1·08	9	0·51	-	–	-	-	5	0·29
Havant	5,417	-	-	6	1·11	4	0·74	-	–	–	–	1	0·18
Hursley	4,095	–	-	2	0·49	5	1·22	–	–	–	–	5	1·22
Kingsclere	8,157	–	–	11	1·35	16	1·96	2	0·25	–	–	5	0·61
Lymington	10,992	–	–	3	0·27	9	0·82	2	0·18	–	-	4	0·36
New Forest	16,566	–	–	7	0·42	16	0·97	2	0·12	1	0·06	2	0·12
Petersfield	10,672	-	–	13	1·22	10	0·94	1	0·09	-	–	–	–
Ringwood	6,503	–	–	3	0·46	1	0·15	2	0·31	-	-	1	0·15
Romsey	6,863	-	–	6	0·87	–	-	–	-	–	–	2	0·29
South Stoneham	17,856	-	–	35	1·96	19	1·06	1	0·06	-	-	2	0·11
Stockbridge	5,957	-	-	3	0·50	1	0·17	1	0·17	–	–	1	0·17
Whitchurch	5,860	-	–	10	1·71	–	–	–	–	1	0·17	14	2·39
Winchester	9,415	-	-	13	1·38	1	0·11	–	-	1	0·11	2	0·21

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate	Cases.	Rate.
County of Isle of Wight.													
ADMINISTRATIVE COUNTY	76,925	–	–	138	1·79	201	2·61	5	0·06	1	0·01	22	0·29
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	51,388	–	–	70	1·36	109	2·12	4	0·08	–	–	21	0·41
AGGREGATE OF RURAL DISTRICTS.	25,537	–	–	68	2·66	92	3·60	1	0·04	1	0·04	1	0·04
BOROUGHS AND URBAN DISTRICTS:—													
Cowes	10,111	–	–	7	0·69	16	1·58	–	–	–	–	3	0·30
East Cowes	5,013	–	–	5	1·00	26	5·19	1	0·20	–	–	1	0·20
Newport	10,648	–	–	24	2·25	12	1·13	3	0·28	–	–	3	0·28
Ryde	8,863	–	–	7	0·79	48	5·42	–	–	–	–	11	1·24
St. Helens	4,432	–	–	4	0·90	5	1·13	–		–	–	1	0·23
Sandown	4,478	–	–	11	2·46	1	0·22	–	–	–	–	1	0·22
Shanklin	3,903	–	–	–	–	1	0·26	–	–	–	–	–	–
Ventnor	3,940	–	–	12	3·05	–	–	–	–	–	–	1	0·25
RURAL DISTRICTS:—													
Isle of Wight	25,537	–	–	68	2·66	92	3·60	1	0·04	1	0·04	1	0·04
County of Stafford.													
ADMINISTRATIVE COUNTY	650,034	–	–	2003	3·08	1009	1·55	58	0·09	27	0·04	320	0·49
COUNTY BOROUGHS:—													
Burton upon Trent ..	44,352	–	–	45	1·01	72	1·62	4	0·09	2	0·05	31	0·70
Smethwick	70,547	–	–	175	2·48	59	0·84	1	0·01	10	0·14	35	0·50
Stoke on Trent	219,755	–	–	721	3·28	866	3·94	31	0·14	16	0·07	175	0·80
Walsall	89,506	–	–	320	3·58	75	0·84	7	0·08	4	0·04	59	0·66
West Bromwich	66,918	–	–	79	1·18	28	0·42	1	0·01	2	0·03	35	0·52
Wolverhampton	93,023	–	–	153	1·64	125	1·34	3	0·03	3	0·03	44	0·47
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	452,765	–	–	1478	3·26	748	1·65	52	0·11	20	0·04	223	0·49
AGGREGATE OF RURAL DISTRICTS.	197,269	–	–	525	2·66	261	1·32	6	0·03	7	0·04	97	0·49
BOROUGHS AND URBAN DISTRICTS:—													
Amblecote	3,048	–	–	2	0·66	–	–	–	–	–	–	–	–
Audley	14,387	–	–	66	4·59	82	5·70	2	0·14	–	–	3	0·21
Biddulph	7,591	–	–	68	8·96	13	1·71	–	–	–	–	6	0·79
Bilston	24,720	–	–	37	1·50	16	0·65	2	0·08	1	0·04	4	0·16
Brierley Hill	12,030	–	–	6	0·50	12	1·00	–	–	–	–	2	0·17
Brownhills	17,101	–	–	34	1·99	37	2·16	4	0·23	2	0·12	6	0·35
Cannock	29,755	–	–	46	1·55	32	1·08	–	–	1	0·03	23	0·77
Coseley	22,383	–	–	45	2·01	6	0·27	1	0·04	–	–	19	0·85
Darlaston	17,036	–	–	23	1·35	3	0·18	1	0·06	–	–	4	0·23
Heath Town	11,918	–	–	21	1·76	3	0·25	1	0·08	–	–	2	0·17
Kidsgrove	8,693	–	–	53	6·10	51	5·87	–	–	–	–	4	0·46
Leek	17,236	–	–	138	8·01	58	3·37	–	–	2	0·12	5	0·29
Lichfield	7,760	–	–	14	1·80	4	0·52	–	–	–	–	1	0·13
Newcastle under Lyme..	18,929	–	–	138	7·29	54	2·85	1	0·05	–	–	5	0·26
Perry Barr	2,426	–	–	9	3·71	1	0·41	–	–	–	–	2	0·82
Quarry Bank	7,435	–	–	10	1·34	3	0·40	–	–	–	–	10	1·34
Rowley Regis	37,398	–	–	51	1·36	19	0·51	3	0·08	1	0·03	19	0·51
Rugeley	4,347	–	–	10	2·30	2	0·46	–	–	1	0·23	1	0·23
Sedgley	16,216	–	–	18	1·11	26	1·60	3	0·19	–	–	21	1·30
Short Heath	4,033	–	–	54	13·39	1	0·25	–	–	–	–	–	–
Smallthorne	13,299	–	–	70	5·26	97	7·29	9	0·68	–	–	11	0·83
*Stafford	21,391	–	–	220	10·28	85	3·97	5	0·23	1	0·05	7	0·33
Stone	5,066	–	–	48	9·47	70	13·82	2	0·39	–	–	–	–
Tamworth	7,053	–	–	–	–	2	0·28	–	–	–	–	3	0·43
Tettenhall	5,276	–	–	–	–	2	0·38	–	–	1	0·19	1	0·19
Tipton	31,342	–	–	15	0·48	16	0·51	7	0·22	2	0·06	25	0·80

* On the 1st April, 1916, the Borough of Stafford was extended so as to include portions of the Rural District of Stafford. Allowance has been made in the calculation of rates.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Stafford— *continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Uttoxeter	5,070	–	–	9	1·78	–	–	–	–	–	–	2	0·39
Wednesbury	27,776	–	–	25	0·90	12	0·43	2	0·07	3	0·11	19	0·68
Wednesfield..	6,747	–	–	16	2·37	7	1·04	1	0·15	–	–	3	0·44
Willenhall	18,529	–	–	15	0·81	3	0·16	2	0·11	1	0·05	9	0·49
Wolstanton United ..	26,774	–	–	217	8·10	31	1·16	6	0·22	4	0·15	6	0·22
RURAL DISTRICTS :—													
Blore Heath..	2,176	–	–	5	2·30	6	2·76	–	–	–	–	–	–
*Blymhill and Weston under Lizard (Parishes).	760	–	–	–	–	1	1·32	–	–	–	–	–	–
Cannock	19,453	–	–	38	1·95	24	1·23	–	–	–	–	18	0·93
Cheadle	25,253	–	–	99	3·92	21	0·83	–	–	1	0·04	12	0·48
Gnosall	4,386	–	–	1	0·23	4	0·91	–	–	–	–	–	–
Kingswinford	19,810	–	–	18	0·91	2	0·10	–	–	–	–	8	0·40
Leek	15,234	–	–	54	3·54	38	2·49	–	–	1	0·07	10	0·66
Lichfield	23,788	–	–	53	2·23	22	0·92	1	0·04	2	0·08	13	0·55
Mayfield	3,764	–	–	14	3·72	4	1·06	–	–	–	–	3	0·80
Newcastle under Lyme..	6,010	–	–	25	4·16	4	0·67	1	0·17	–	–	–	–
Seisdon	14,934	–	–	24	1·61	25	1·67	–	–	–	–	10	0·67
‡Stafford	11,630	–	–	77	6·62	38	3·27	3	0·26	2	0·17	2	0·17
Stoke upon Trent ..	4,491	–	–	9	2·00	7	1·56	–	–	–	–	3	0·67
Stone	13,273	–	–	26	1·96	24	1·81	–	–	–	–	3	0·23
†Tamworth (part of) ..	4,964	–	–	3	0·60	2	0·40	–	–	–	–	2	0·40
Tutbury	8,195	–	–	45	5·49	25	3·05	1	0·12	–	–	4	0·49
Uttoxeter	7,043	–	–	14	1·99	4	0·57	–	–	–	–	–	–
Walsall	12,105	–	–	20	1·65	10	0·83	–	–	1	0·08	9	0·74
County of Suffolk, East.													
ADMINISTRATIVE COUNTY	182,573	–	–	241	1·32	220	1·20	19	0·10	5	0·03	55	0·30
COUNTY BOROUGH :— Ipswich	72,245	–	–	164	2·27	71	0·98	14	0·19	5	0·07	36	0·50
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	73,967	–	–	72	0·97	122	1·65	6	0·08	2	0·03	21	0·28
AGGREGATE OF RURAL DISTRICTS.	108,606	–	–	169	1·56	98	0·90	13	0·12	3	0·03	34	0·31
BOROUGHS AND URBAN DISTRICTS :—													
Aldeburgh	2,144	–	–	1	0·47	–	–	–	–	–	–	–	–
Beccles	6.627	–	–	20	3·02	1	0·15	–	–	–	–	1	0·15
Bungay	2,819	–	–	11	3·90	2	0·71	1	0·35	–	–	–	–
Eye	1,754	–	–	–	–	–	–	–	–	–	–	2	1·14
Felixstowe	7,679	–	–	3	0·39	9	1·17	2	0·26	–	–	1	0·13
Halesworth	2,071	–	–	–	–	1	0·48	–	–	–	–	–	–
Leiston-cum-Sizewell ..	4,098	–	–	1	0·24	14	3·42	–	–	–	–	–	–
Lowestoft	30,652	–	–	13	0·42	28	0·91	3	0·10	–	–	15	0·49
Oulton Broad	3,972	–	–	16	4·03	38	9·57	–	–	–	–	–	–
Saxmundham	1,359	–	–	4	2·94	2	1·47	–	–	1	0·74	–	–
Southwold	2,259	–	–	–	–	3	1·33	–	–	–	–	–	–
Stowmarket	4,322	–	–	2	0·46	24	5·55	–	–	1	0·23	2	0·46
Woodbridge..	4,211	–	–	1	0·24	–	–	–	–	–	–	–	–
RURAL DISTRICTS :—													
Blything	16,218	–	–	5	0·31	13	0·80	–	–	1	0·06	8	0·49
Bosmere and Claydon ..	12,196	–	–	9	0·74	3	0·25	2	0·26	–	–	4	0·33
East Stow	6,157	–	–	2	0·32	32	5·20	–	–	2	0·32	5	0·81
Hartismere	10,444	–	–	11	1·05	2	0·19	–	–	–	–	4	0·38
Hoxne	9,388	–	–	17	1·81	4	0·43	–	–	–	–	3	0·32
Mutford and Lothingland	10,323	–	–	16	1·55	15	1·45	3	0·29	–	–	3	0·29
Plomesgate	14,148	–	–	19	1·34	20	1·41	–	–	–	–	–	–
Samford	11,595	–	–	60	5·17	2	0·17	2	0·17	–	–	3	0·26
Wangford	4,420	–	–	10	2·26	1	0·23	–	–	–	–	–	–
Woodbridge..	13,717	–	–	20	1·46	6	0·44	6	0·44	–	–	4	0·29

* These parishes are administered by the Rural District Council of Shifnal (Salop).
† The remaining part of the Rural District of Tamworth is in the Administrative County of Warwick
‡ On the 1st April, 1916, the Borough of Stafford was extended so as to include portions of the Rural District of Stafford. Allowance has been made in the calculation of rates.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Suffolk, West.													
ADMINISTRATIVE COUNTY	103,030	–	–	177	1·72	100	0·97	6	0·06	3	0·03	35	0·34
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	38,282	–	–	83	2·17	36	0·94	5	0·13	3	0·08	12	0·31
AGGREGATE OF RURAL DISTRICTS.	64,748	–	–	94	1·45	64	0·99	1	0·02	–	–	23	0·36
BOROUGHS AND URBAN DISTRICTS:—													
Bury St. Edmunds ..	14,893	–	–	41	2·75	15	1·01	–	–	3	0·20	9	0·60
Glemsford	1,329	–	–	–	–	1	0·75	–	–	–	–	–	–
Hadleigh	2,863	–	–	1	0·35	–	–	–	–	–	–	–	–
Haverhill	4,258	–	–	–	–	18	4·23	–	–	–	–	2	0·47
Newmarket	8,698	–	–	23	2·64	2	0·23	4	0·46	–	–	–	–
Sudbury	6,241	–	–	18	2·88	–	–	1	0·16	–	–	1	0·16
RURAL DISTRICTS:—													
Brandon	5,337	–	–	11	2·06	19	3·56	–	–	–	–	4	0·75
Clare	7,276	–	–	8	1·10	5	0·69	–	–	–	–	2	0·27
Cosford	10,143	–	–	6	0·59	22	2·17	–	–	–	–	4	0·39
Melford	11,402	–	–	9	0·79	2	0·18	–	–	–	–	1	0·09
Mildenhall	7,462	–	–	16	2·14	–	–	1	0·13	–	–	4	0·54
Moulton	2,059	–	–	7	3·40	–	–	–	–	–	–	1	0·49
Thedwastre	8,015	–	–	8	1·00	12	1·50	–	–	–	–	3	0·37
Thingoe	13,054	–	–	29	2·22	4	0·31	–	–	–	–	4	0·31
County of Surrey.													
ADMINISTRATIVE COUNTY	647,078	–	–	990	1·53	695	1·07	55	0·08	22	0·03	257	0·40
COUNTY BOROUGH:— Croydon	175,765	–	–	300	1·71	309	1·76	12	0·07	8	0·05	62	0·35
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	503,965	–	–	772	1·53	591	1·17	44	0·09	20	0·04	203	0·40
AGGREGATE OF RURAL DISTRICTS.	143,113	–	–	218	1·52	104	0·73	11	0·08	2	0·01	54	0·38
BOROUGHS AND URBAN DISTRICTS:—													
Barnes	31,960	–	–	92	2·88	34	1·06	2	0·06	1	0·03	8	0·25
Beddington and Wallington.	15,604	–	–	15	0·96	26	1·67	1	0·06	1	0·06	10	0·64
Carshalton	12,282	–	–	18	1·47	36	2·93	1	0·08	–	–	1	0·08
Caterham	7,197	–	–	20	2·78	3	0·42	1	0·14	–	–	–	–
Chertsey	13,024	–	–	4	0·31	8	0·61	1	0·08	–	–	5	0·38
Coulsdon and Purley ..	17,495	–	–	16	0·91	38	2·17	7	0·40	2	0·11	10	0·57
Dorking	6,867	–	–	11	1·60	4	0·58	–	–	–	–	2	0·29
East and West Molesey ..	6,418	–	–	16	2·49	6	0·93	1	0·16	–	–	2	0·31
Egham	11,443	–	–	26	2·27	9	0·79	3	0·26	–	–	3	0·26
Epsom	11,624	–	–	21	1·81	19	1·63	3	0·26	–	–	17	1·46
Esher and the Dittons ..	12,370	–	–	6	0·49	1	0·08	2	0·16	–	–	1	0·08
Farnham	11,295	–	–	50	4·43	22	1·95	–	–	–	–	1	0·09
Frimley	9,803	–	–	26	2·65	11	1·12	–	–	–	–	2	0·20
Godalming	8,290	–	–	19	2·29	12	1·45	–	–	1	0·12	2	0·24
Guildford	22,853	–	–	15	0·66	8	0·35	–	–	2	0·09	3	0·13
Ham	1,155	–	–	11	9·52	–	–	–	–	–	–	1	0·87
Haslemere	3,835	–	–	2	0·52	3	0·78	–	–	–	–	–	–
Kingston upon Thames ..	35,632	–	–	34	0·95	28	0·79	8	0·22	3	0·08	39	1·09
Leatherhead	5,060	–	–	5	0·99	33	6·52	–	–	–	–	–	–
Merton and Morden ..	15,832	–	–	19	1·20	19	1·20	–	–	1	0·06	5	0·32
Mitcham	33,044	–	–	50	1·51	42	1·27	1	0·03	2	0·06	21	0·64
Reigate	26,161	–	–	102	3·90	10	0·38	–	–	1	0·04	12	0·46
Richmond	33,199	–	–	55	1·66	32	0·96	4	0·12	–	–	11	0·33
Surbiton	17,179	–	–	11	0·64	7	0·41	1	0·06	–	–	6	0·35
Sutton	19,737	–	–	36	1·82	12	0·61	1	0·05	1	0·05	4	0·20
The Maldens and Coombe	13,694	–	–	9	0·66	7	0·51	1	0·07	1	0·07	7	0·51
Walton upon Thames ..	12,686	–	–	14	1·10	2	0·16	1	0·08	–	–	1	0·08
Weybridge	6,189	–	–	2	0·32	7	1·13	–	–	1	0·16	–	–
Wimbledon	55,451	–	–	51	0·92	126	2·27	4	0·07	2	0·04	20	0·36
Windlesham	4,112	–	–	4	0·97	1	0·24	–	–	–	–	2	0·49
Woking	22,474	–	–	12	0·53	25	1·11	1	0·04	1	0·04	7	0·31
RURAL DISTRICTS:—													
Chertsey	9,487	–	–	9	0·95	3	0·32	–	–	1	0·11	–	–
Dorking	9,713	–	–	16	1·65	4	0·41	–	–	–	–	3	0·31

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Surrey—*continued.*													
RURAL DISTRICTS:—													
Epsom	27,628	–	–	49	1·77	29	1·05	3	0·11	–	–	18	0·65
Farnham	16,271	–	–	39	2·40	20	1·23	2	0·12	1	0·06	4	0·25
Godstone	21,813	–	–	24	1·10	15	0·69	2	0·09	–	–	7	0·32
Guildford	17,515	–	–	25	1·43	3	0·17	–	–	–	–	1	0·06
Hambledon	21,360	–	–	29	1·36	4	0·19	1	0·05	1	0·05	9	0·42
Reigate	19,326	–	–	27	1·40	26	1·35	3	0·16	–	–	12	0·62
County of Sussex, East.													
ADMINISTRATIVE COUNTY	218,212	–	–	289	1·32	200	0·92	15	0·07	2	0·01	70	0·32
COUNTY BOROUGHS:—													
Brighton	115,224	–	–	185	1·61	174	1·51	6	0·05	4	0·03	49	0·43
Eastbourne	45,933	–	–	137	2·98	118	2·57	6	0·13	1	0·02	13	0·28
Hastings	49,979	–	–	105	2·10	120	2·40	–	–	2	0·04	18	0·36
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	106,240	–	–	128	1·20	161	1·52	8	0·08	1	0·01	39	0·37
AGGREGATE OF RURAL DISTRICTS.	111,972	–	–	161	1·44	39	0·35	7	0·06	1	0·01	31	0·28
BOROUGHS AND URBAN DISTRICTS:—													
Battle	2,615	–	–	2	0·76	–	–	–	–	1	0·38	1	0·38
Bexhill	13,972	–	–	11	0·79	18	1·29	–	–	–	–	2	0·14
Burgess Hill..	4,726	–	–	1	0·21	1	0·21	–	–	–	–	6	1·27
Cuckfield	1,728	–	–	5	2·89	–	–	–	–	–	–	1	0·58
East Grinstead	6,603	–	–	5	0·76	14	2·12	–	–	–	–	–	–
Haywards Heath	4,406	–	–	12	2·72	–	–	2	0·45	–	–	3	0·68
Hove	38,194	–	–	29	0·76	87	2·28	2	0·05	–	–	13	0·34
Lewes	9,936	–	–	29	2·92	3	0·30	1	0·10	–	–	5	0·50
Newhaven	6,444	–	–	2	0·31	17	2·64	1	0·16	–	–	3	0·47
Portslade by Sea	6,531	–	–	12	1·84	8	1·22	–	–	–	–	2	0·31
Rye	3,659	–	–	14	3·83	–	–	–	–	–	–	–	–
Seaford	4,461	–	–	6	1·34	13	2·91	–	–	–	–	3	0·67
Uckfield	2,965	–	–	–	–	–	–	2	0·67	–	–	–	–
RURAL DISTRICTS:—													
Battle	5,611	–	–	2	0·36	–	–	–	–	1	0·18	–	–
Chailey	10,202	–	–	10	0·98	8	0·78	2	0·20	–	–	3	0·29
Cuckfield	15,143	–	–	20	1·32	8	0·53	1	0·07	–	–	5	0·33
Eastbourne	4,955	–	–	22	4·44	–	–	–	–	–	–	–	–
East Grinstead	12,074	–	–	9	0·75	7	0·58	–	–	–	–	4	0·33
Hailsham	15,154	–	–	51	3·37	4	0·26	–	–	–	–	6	0·40
Hastings	1,421	–	–	3	2·11	–	–	–	–	–	–	1	0·70
Newhaven	4,246	–	–	–	–	4	0·94	1	0·24	–	–	2	0·47
Rye	6,326	–	–	19	3·00	–	–	–	–	–	–	1	0·16
Steyning East	2,496	–	–	–	–	–	–	1	0·40	–	–	2	0·80
Ticehurst	12,260	–	–	19	1·55	3	0·24	–	–	–	–	3	0·24
Uckfield	22,084	–	–	6	0·27	5	0·23	2	0·09	1	0·05	4	0·18
County of Sussex, West.													
ADMINISTRATIVE COUNTY	158,706	–	–	320	2·02	138	0·87	17	0·11	3	0·02	50	0·32
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	75,902	–	–	157	2·07	98	1·29	13	0·17	2	0·03	29	0·38
AGGREGATE OF RURAL DISTRICTS.	82,804	–	–	163	1·97	40	0·48	4	0·05	1	0·01	21	0·25
BOROUGHS AND URBAN DISTRICTS:—													
Arundel	2,432	–	–	16	6·58	5	2·06	2	0·82	–	–	–	–
Bognor	7,581	–	–	5	0·66	2	0·26	–	–	–	–	3	0·40

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Sussex, West—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Chichester	9,962	–	–	39	3·91	24	2·41	2	0·20	1	0·10	4	0·40
Horsham	10,237	–	–	2	0·20	2	0·20	–	–	–	–	1	0·10
Littlehampton	7,953	–	–	15	1·89	–	–	–	–	–	–	4	0·50
Shoreham by Sea	5,559	–	–	35	6·30	2	0·36	–	–	–	–	6	1·08
Southwick	4,412	–	–	5	1·13	9	2·04	–	–	–	–	–	–
Worthing	27,766	–	–	40	1·44	54	1·94	9	0·32	1	0·04	11	0·40
RURAL DISTRICTS:—													
East Preston	6,335	–	–	53	8·37	2	0·32	–	–	–	–	2	0·32
Horsham	18,865	–	–	32	1·70	6	0·32	–	–	–	–	4	0·21
Midhurst	13,247	–	–	12	0·91	2	0·15	–	–	–	–	1	0·08
Petworth	7,822	–	–	8	1·02	6	0·77	1	0·13	–	–	2	0·26
Thakeham	7,430	–	–	11	1·48	2	0·27	1	0·13	–	–	–	–
Westbourne	7,900	–	–	11	1·39	15	1·90	–	–	–	–	2	0·25
West Hampnett	13,290	–	–	32	2·41	5	0·38	2	0·15	–	–	7	0·53
West Steyning	7,915	–	–	4	0·51	2	0·25	–	–	1	0·13	3	0·38
County of Warwick.													
ADMINISTRATIVE COUNTY.	299,693	–	–	659	2·20	324	1·08	20	0·07	20	0·07	192	0·64
COUNTY BOROUGHS:—													
Birmingham	847,555	–	–	1,865	2·20	993	1·17	29	0·03	169	0·20	640	0·76
Coventry	120,441	–	–	391	3·25	332	2·76	10	0·08	8	0·07	53	0·44
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	133,530	–	–	255	1·91	147	1·10	7	0·05	8	0·06	102	0·76
AGGREGATE OF RURAL DISTRICTS.	166,163	–	–	404	2·43	177	1·07	13	0·08	12	0·07	90	0·54
BOROUGHS AND URBAN DISTRICTS:—													
Bulkington	2,011	–	–	–	–	1	0·50	–	–	1	0·50	1	0·50
Kenilworth	5,723	–	–	1	0·17	6	1·05	1	0·17	1	0·17	8	1·40
Nuneaton	37,599	–	–	38	1·01	11	0·29	–	–	3	0·08	16	0·43
Royal Leamington Spa ..	25,632	–	–	20	0·78	33	1·29	–	–	–	–	16	0·62
Rugby	22,500	–	–	118	5·24	55	2·44	2	0·09	3	0·13	19	0·84
Stratford-on-Avon ..	7,902	–	–	13	1·65	19	2·40	2	0·25	–	–	8	1·01
Sutton Coldfield	21,269	–	–	48	2·26	4	0·19	–	–	–	–	10	0·47
Warwick	10,894	–	–	17	1·56	18	1·65	2	0·18	–	–	24	2·20
RURAL DISTRICTS:—													
Alcester	11,139	–	–	27	2·42	19	1·71	1	0·09	–	–	8	0·72
Atherstone	19,057	–	–	38	1·99	5	0·26	1	0·05	4	0·21	9	0·47
Brailes	5,376	–	–	–	–	2	0·37	–	–	1	0·19	2	0·37
Coventry	2,199	–	–	2	0·91	3	1·36	–	–	–	–	–	–
Farnborough	1,298	–	–	–	–	–	–	–	–	–	–	2	1·54
Foleshill	27,015	–	–	18	0·67	23	0·85	1	0·04	3	0·11	11	0·41
Meriden	14,929	–	–	37	2·48	1	0·07	–	–	–	–	16	1·07
Monks Kirby	1,439	–	–	2	1·39	–	–	–	–	–	–	–	–
Nuneaton	2,757	–	–	–	–	–	–	–	–	–	–	1	0·36
Rugby	17,839	–	–	141	7·90	48	2·69	5	0·28	–	–	12	0·67
Solihull	18,804	–	–	28	1·49	10	0·53	3	0·16	1	0·05	10	0·53
Southam	9,026	–	–	62	6·87	47	5·21	–	–	1	0·11	1	0·11
Stratford-on-Avon ..	9,819	–	–	16	1·63	5	0·51	–	–	1	0·10	6	0·61
*Tamworth (part of) ..	15,547	–	–	10	0·64	6	0·39	–	–	1	0·06	9	0·58
Warwick	9,919	–	–	23	2·32	8	0·81	2	0·20	1	0·10	3	0·30

* The remaining part of the Rural District of Tamworth is in the Administrative County of Stafford. The figures for the entire district are:—

20,511	–	–	13	0·63	8	0·39	–	–	1	0·05	11	0·54

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Westmorland.													
ADMINISTRATIVE COUNTY	58,201	-	-	68	1·17	23	0·40	8	0·14	1	0·02	38	0·65
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	24,536	-	-	37	1·51	13	0·53	2	0·08	-	-	15	0·61
AGGREGATE OF RURAL DISTRICTS.	33,665	-	-	31	0·92	10	0·30	6	0·18	1	0·03	23	0·68
BOROUGHS AND URBAN DISTRICTS:—													
Ambleside	2,118	-	-	5	2·36	1	0·47	-	-	-	-	1	0·47
Appleby	1,655	-	-	-	-	2	1·21	-		-	-	1	0·60
Grasmere	737	-	-	14	19·00	1	1·36	-	-	-	-	-	-
Kendal	12,722	-	-	8	0·63	8	0·63	-	-	-	-	12	0·94
Kirkby Lonsdale	1,336	-	-	-	-	-	-	1	0·75	-	-	1	0·75
Shap	855	-	-	2	2·34	1	1·17	-	-	-	-	-	-
Windermere	5,113	-	-	8	1·56	-	-	1	0·20	-	-	-	-
RURAL DISTRICTS:—													
East Westmorland ..	10,509	-	-	8	0·76	2	0·19	-	-	1	0·10	7	0·67
South Westmorland ..	17,185	-	-	20	1·16	5	0·29	5	0·29	-	-	15	0·87
West Ward	5,971	-	-	3	0·50	3	0·50	1	0·17	-	-	1	0·17
County of Wilts.													
ADMINISTRATIVE COUNTY	268,806	-	-	747	2·78	318	1·18	17	0·06	14	0·05	87	0·32
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	122,536	-	-	519	4·24	183	1·49	13	0·11	4	0·03	45	0·37
AGGREGATE OF RURAL DISTRICTS.	146,270	-	-	228	1·56	135	0·92	4	0·03	10	0·07	42	0·29
BOROUGHS AND URBAN DISTRICTS:—													
Bradford on Avon ..	4,282	-	-	-	-	1	0·23	-	-	-	-	1	0·23
Calne	3,354	-	-	-	-	3	0·89	1	0·30	-	-	3	0·89
Chippenham	7,196	-	-	78	10·84	15	2·08	-	-	-	-	4	0·56
Devizes	5,981	-	-	10	1·67	16	2·68	-	-	-	-	2	0·33
Malmesbury	2,335	-	-	-	-	1	0·43	-	-	-	-	-	-
Marlborough	3,597	-	-	2	0·56	6	1·67	-	-	1	0·28	1	0·28
Melksham	3,328	-	-	3	0·90	-	-	-	-	-	-	1	0·30
Salisbury	20,289	-	-	67	3·30	47	2·32	1	0·05	-	-	3	0·15
Swindon	50,237	-	-	347	6·91	83	1·65	1	0·02	2	0·04	25	0·50
Trowbridge	11,181	-	-	8	0·72	3	0·27	9	0·80	-	-	1	0·09
Warminster	5,363	-	-	1	0·19	3	0·56	1	0·19	1	0·19	3	0·56
Westbury	3,334	-	-	1	0·30	4	1·20	-	-	-	-	1	0·30
Wilton	2,059	-	-	2	0·97	1	0·49	-	-	-	-	-	-
RURAL DISTRICTS:—													
Amesbury	11,627	-	-	16	1·38	8	0·69	-	-	2	0·17	2	0·17
Bradford on Avon ..	4,861	-	-	7	1·44	6	1·23	-	-	-	-	4	0·82
Calne	4,161	-	-	1	0·24	6	1·44	-	-	-	-	1	0·24
Chippenham	13,935	-	-	16	1·15	7	0·50	1	0·07	-	-	7	0·50
Cricklade and Wootton Bassett.	10,089	-	-	5	0·50	5	0·50	-	-	1	0.10	1	0·10
Devizes	10,339	-	-	20	1·93	6	0·58	-	-	-	-	1	0·10
Highworth	14,052	-	-	85	6·05	32	2·28	-	-	1	0·07	4	0·28
Malmesbury	8,423	-	-	3	0·36	6	0·71	-	-	-	-	7	0·83
Marlborough	3,986	-	-	-	-	3	0·75	-	-	-	-	1	0·25
Melksham	4,482	-	-	2	0·45	1	0·22	1	0·22	-	-	-	-
Mere	4,528	-	-	4	0·88	2	0·44	-	-	-	-	2	0·44
Pewsey	11,656	-	-	27	2·32	9	0·77	-	-	3	0 26	6	0·51
Ramsbury	6,356	-	-	6	0·94	1	0·16	-	-	-	-	3	0·47
Salisbury	9,455	-	-	21	2·22	15	1·59	-	-	-	-	-	-
*Tetbury (part of)	313	-	-	-	-	-	-	-	-	-	-	-	-
Tisbury	7,099	-	-	1	0·14	7	0·99	1	0·14	-	-	-	-
Warminster	6,062	-	-	1	0·16	9	1·48	1	0·16	3	0·49	1	0·16
Westbury and Whorwellsdown.	6,186	-	-	1	0·16	8	1·29	-	-	-	-	2	0·32
Wilton	8,660	-	-	12	1·39	4	0·46	-	-	-	-	-	-

* The remaining part of the Rural District of Tetbury is in the Administrative County of Gloucester

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Worcester.													
ADMINISTRATIVE COUNTY	271,442	-	-	449	1·65	414	1·53	9	0·03	17	0·06	130	0·48
COUNTY BOROUGHS:—													
Dudley (including Dudley Castle Hill).	49,865	-	-	88	1·76	4	0·08	2	0·04	2	0·04	28	0·56
Worcester	44,539	-	-	52	1·17	35	0·79	10	0·22	2	0·04	31	0·70
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	149,264	-	-	273	1·83	275	1·84	6	0·04	9	0·06	76	0·51
AGGREGATE OF RURAL DISTRICTS.	122,178	-	-	176	1·44	139	1·14	3	0·02	8	0·07	54	0·44
BOROUGHS AND URBAN DISTRICTS:—													
Bewdley	2,470	-	-	-	-	1	0·40	-	-	-	-	3	1·21
Bromsgrove..	8,286	-	-	2	0·24	3	0·36	-	-	-	-	2	0·24
Droitwich	3,422	-	-	41	11·98	14	4·09	-	-	-	-	-	-
Evesham	7,683	-	-	38	4·95	12	1·56	-	-	-	-	13	1·69
Kidderminster	24,402	-	-	28	1·15	21	0·86	-	-	1	0·04	4	0·16
Lye and Wollescote ..	11,594	-	-	46	3·97	6	0·52	1	0·09	2	0·17	13	1·12
Malvern	14,156	-	-	18	1·27	33	2·33	2	0·14	-	-	1	0·07
North Bromsgrove ..	6,587	-	-	7	1·06	9	1·37	-	-	-	-	-	-
Oldbury	34,630	-	-	60	1·73	18	0·52	2	0·06	4	0·12	21	0·61
Redditch	15,560	-	-	7	0·45	136	8·74	1	0·06	1	0·06	14	0·90
Stourbridge	16,393	-	-	21	1·28	17	1·04	-	-	1	0·06	5	0·31
Stourport	4,081	-	-	5	1·23	5	1·23	-	-	-	-	-	-
RURAL DISTRICTS:—													
Bromsgrove..	14,840	-	-	20	1·35	22	1·48	-	-	1	0·07	7	0·47
Droitwich	11,319	-	-	19	1·68	11	0·97	-	-	1	0·09	6	0·53
Evesham	8,736	-	-	46	5·27	15	1·72	-	-	-	-	9	1·03
Feckenham	5,167	-	-	5	0·97	25	4·84	-	-	-	-	-	-
Halesowen	26,954	-	-	23	0·85	28	1·04	-	-	2	0·07	11	0·41
Kidderminster	6,758	-	-	8	1·18	7	1·04	-	-	-	-	3	0·44
Martley	11,624	-	-	24	2·06	11	0·95	-	-	1	0·09	-	-
Pershore	11,714	-	-	16	1·37	2	0·17	-	-	-	-	10	0·85
*Redmarley d'Abitôt and Staunton (parishes).	1,104	-	-	-	-	-	-	-	-	-	-	-	-
Rock	2,051	-	-	1	0·49	-	-	-	-	1	0·49	1	0·49
Shipston on Stour.. ..	3,962	-	-	-	-	14	3·53	-	-	1	0·25	1	0·25
†Stow on the Wold (part of).	275	-	-	-	-	-	-	-	-	-	-	-	-
Tenbury	4,334	-	-	7	1·62	2	0·46	-	-	1	0·23	-	-
†Tewkesbury (part of) ..	2,022	-	-	-	-	-	-	-	-	-	-	1	0·49
Upton upon Severn ..	11,215	-	-	7	0·62	2	0·18	3	0·27	-	-	5	0·45
†Winchcomb (part of) ..	103	-	-	-	-	-	-	-	-	-	-	-	-
County of Yorkshire, East Riding.													
ADMINISTRATIVE COUNTY	145,189	1	0·01	210	1·45	86	0·59	19	0·13	5	0·03	75	0·52
COUNTY BOROUGHS:—													
Kingston upon Hull ..	265,764	-	-	626	2·36	360	1·35	82	0·31	12	0·05	141	0·53
York	77,177	-	-	318	4·12	42	0·54	25	0·32	2	0·03	29	0·38
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	57,321	-	-	80	1·40	37	0·65	9	0·16	1	0·02	35	0·61
AGGREGATE OF RURAL DISTRICTS.	87,868	-	-	130	1·48	49	0·56	10	0·11	4	0·05	40	0·46

* These Parishes are administered by the Rural District Council of Newent (Glos.).
† The remaining parts of the Rural Districts of Stow-on-the-Wold, Tewkesbury, and Winchcomb are in the Administrative County of Gloucester.

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Yorkshire, East Riding—*continued.*													
BOROUGHS AND URBAN DISTRICTS :—													
Beverley	12,767	1	0·08	10	0·78	14	1·10	-	-	–	–	13	1·02
Bridlington	13,200	–	–	21	1·59	3	0·23	1	0·08	–	–	4	0·30
Cottingham	4,569	–	–	11	2·41	4	0·88	–	–	–	–	10	2·19
Filey	3,027	–	–	-	–	–	–	1	0·33	–	–	1	0·33
Great Driffield	5,393	–	–	–	–	1	0·19	6	1·11	1	0·19	3	0·56
Hedon	1,186	–	–	–	–	–	–	–	–	–	–	–	–
Hessle	5,517	–	–	12	2·18	-	–	1	0·18	–	–	–	–
Hornsea	3,145	–	–	2	0·64	-	–	-	-	–	–	1	0·32
Norton	3,581	–	–	13	3·63	14	3·91	-	–	–	–	2	0·56
Pocklington	2,434	–	–	6	2·47	–	–	–	-	–	–	–	–
Withernsea	2,502	–	–	5	2·00	1	0·40	–	–	–	–	1	0·40
RURAL DISTRICTS :—													
Beverley	10,039	–	–	21	2·09	10	1·00	-	–	–	–	7	0·70
Bridlington	7,159	–	–	7	0·98	–	–	1	0·14	1	0·14	–	–
Driffield	11,098	–	–	23	2·07	5	0·45	2	0·18	2	0·18	3	0·27
Escrick	5,008	–	-	21	4·19	2	0·40	1	0·20	–	–	–	–
Howden	11,559	–	-	20	1·73	5	0·43	2	0·17	–	–	6	0·52
Norton	5,148	–	–	1	0·19	5	0·97	–	–	–	–	–	–
Patrington	6,478	–	–	6	0·93	7	1·08	2	0·31	–	–	8	1·23
Pocklington	10,287	–	–	14	1·36	5	0·49	2	0·19	1	0·10	1	0·10
Riccall	4,078	–	–	4	0·98	-	–	-	–	–	–	–	–
Sculcoates	8,454	–	–	6	0·71	5	0·59	-	-	–	–	5	0·59
Sherburn	1,952	–	–	–	–	–	–	-	-	–	–	1	0·51
Skirlaugh	6,608	–	–	7	1·06	5	0·76	-	-	–	–	9	1·36
County of Yorkshire, North Riding.													
ADMINISTRATIVE COUNTY	276,291	–	–	334	1·21	280	1·01	61	0·22	2	0·01	126	0·46
COUNTY BOROUGH :— Middlesbrough	115,548	–	–	409	3·54	366	3·17	34	0·29	8	0·07	45	0·39
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	150,316	–	–	189	1·26	201	1·34	29	0·19	1	0·01	78	0·52
AGGREGATE OF RURAL DISTRICTS.	125,975	–	–	145	1·15	79	0·63	32	0·25	1	0·01	48	0·38
BOROUGHS AND URBAN DISTRICTS :—													
Eston	27,182	–	–	11	0·40	56	2·06	12	0·44	–	–	19	0·70
Guisborough	6,364	–	–	5	0·79	14	2·20	-	–	–	–	9	1·41
Hinderwell	2,304	–	–	1	0·43	–	–	–	–	–	–	-	–
Kirklington cum Upsland	240	–	–	–	–	–	–	–	–	–	–	–	–
Loftus	8,026	–	–	5	0·62	7	0·87	–	–	–	–	4	0·50
Malton	4,274	–	–	3	0·70	4	0·94	–	–	–	–	3	0·70
Masham	2,224	–	–	–	–	–	–	–	–	–	–	–	–
Northallerton	4,315	–	–	2	0·46	4	0·93	1	0·23	–	–	3	0·70
Pickering	3,397	–	–	–	–	–	–	–	–	–	–	1	0·29
Redcar	10,474	–	–	8	0·76	17	1·62	8	0·76	–	–	3	0·29
Richmond	3,396	–	–	5	1·47	3	0·88	–	–	–	–	6	1·77
Saltburn by the Sea	3,101	–	–	–	–	3	0·97	–	–	–	–	1	0·32
Scalby	1,206	–	–	1	0·83	–	–	–	–	–	–	2	1·66
Scarborough	31,221	–	–	93	2·98	20	0·64	1	0·03	1	0·22	13	0·42
Skelton and Brotton	14,514	–	–	10	0·69	40	2·76	3	0·21	–	–	7	0·48
Thornaby on Tees	18,075	–	–	24	1·33	32	1·77	1	0·06	–	–	5	0·28
Whitby	10,003	–	–	21	2·10	1	0·10	3	0·30	–	–	2	0·20
RURAL DISTRICTS :—													
Aysgarth	4,052	–	–	8	1·97	-	-	1	0·25	–	–	2	0·49
Bedale	6,389	–	–	9	1·41	4	0·63	5	0·78	–	–	5	0·78
Croft	2,097	–	–	–	–	–	–	4	1·91	–	–	1	0·48
Easingwold	9,667	–	–	20	2·07	2	0·21	3	0·31	–	–	3	0·31
Flaxton	7,354	–	–	15	2·04	5	0·68	12	1·63	–	–	2	0·27
Guisborough	6,888	–	–	18	2·61	15	2·18	–	–	–	–	2	0·29
Helmsley	4,581	–	–	1	0·22	–	–	–	–	–	–	2	0·44

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox. Cases.	Small-pox. Rate.	Scarlet Fever. Cases.	Scarlet Fever. Rate.	Diphtheria. Cases.	Diphtheria. Rate.	Enteric Fever. Cases.	Enteric Fever. Rate.	Puerperal Fever. Cases.	Puerperal Fever. Rate.	Erysipelas. Cases.	Erysipelas. Rate.
County of Yorkshire, North Riding—*continued.*													
RURAL DISTRICTS:—													
Kirkby Moorside	4,651	–	–	13	2·80	–	–	–	–	1	0·22	3	0·65
Leyburn	5,846	–	–	6	1·03	7	1·20	2	0·34	–	–	–	–
Malton	5,395	–	–	8	1·48	4	0·74	1	0·19	–	–	1	0·19
Middlesbrough	2,135	–	–	–	–	1	0·47	–	–	–	–	–	–
Northallerton	7,059	–	–	4	0·57	6	0·85	1	0·14	–	–	1	0·14
Pickering	6,164	–	–	9	1·46	1	0·16	–	–	–	–	–	–
Reeth	2,283	–	–	3	1·31	3	1·31	–	–	–	–	7	3·07
Richmond	7,775	–	–	5	0·64	5	0·64	–	–	–	–	2	0·26
Scarborough	5,964	–	–	4	0·67	6	1·01	–	–	–	–	3	0·50
Startforth	4,488	–	–	–	–	8	1·78	–	–	–	–	–	–
Stokesley	11,330	–	–	14	1·24	4	0·35	3	0·26	–	–	7	0·62
Thirsk	11,753	–	–	4	0·34	6	0·51	–	–	–	–	7	0·60
Wath	2,001	–	–	–	–	2	1·00	–	–	–	–	–	–
Whitby	8,103	–	–	4	0·49	–	–	–	–	–	–	–	–
County of Yorkshire, West Riding.													
ADMINISTRATIVE COUNTY	1,405,390	–	–	2,680	1·91	2,047	1·46	272	0·19	61	0·04	856	0·61
COUNTY BOROUGHS:—													
Barnsley	49,183	–	–	51	1·04	50	1·02	1	0·02	2	0·04	20	0·41
Bradford	271,105	–	–	315	1·16	516	1·90	71	0·26	32	0·12	165	0·61
Dewsbury	51,855	–	–	69	1·33	51	0·98	6	0·12	3	0·06	13	0·25
Halifax	97,047	–	–	171	1·76	77	0·79	11	0·11	6	0·06	48	0·49
Huddersfield	107,969	–	–	155	1·44	175	1·62	19	0·18	3	0·03	38	0·35
Leeds	438,254	–	–	881	2·01	420	0·96	51	0·12	25	0·06	231	0·53
Rotherham	63,338	–	–	98	1·55	67	1·06	18	0·28	2	0·03	36	0·57
Sheffield	465,494	–	–	841	1·81	816	1·75	58	0·12	48	0·10	329	0·71
Wakefield	47,293	1	0·02	51	1·08	85	1·80	21	0·44	4	0·08	18	0·38
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	1,045,748	–	–	1,803	1·72	1,670	1·60	182	0·17	47	0·04	679	0·65
AGGREGATE OF RURAL DISTRICTS.	359,642	–	–	877	2·44	377	1·05	90	0·25	14	0·04	177	0·49
BOROUGHS AND URBAN DISTRICTS:—													
Adwick le Street	10,144	–	–	38	3·75	9	0·89	1	0·10	–	–	5	0·49
Altofts	4,661	–	–	21	4·51	5	1·07	–	–	2	0·43	8	1·72
Ardsley	6,793	–	–	37	5·45	15	2·21	–	–	–	–	1	0·15
Ardsley East and West ..	8,430	–	–	10	1·19	2	0·24	–	–	–	–	11	1·30
Baildon	6,262	–	–	5	0·80	10	1·60	1	0·16	–	–	4	0·64
Barkisland	1,493	–	–	3	2·01	–	–	–	–	–	–	1	0·67
Barnoldswick	11,984	–	–	17	1·42	2	0·17	1	0·08	–	–	8	0·67
Batley..	35,135	–	–	35	1·00	157	4·47	5	0·14	3	0·09	17	0·48
Bentley with Arksey ..	10,883	–	–	23	2·11	28	2·57	–	–	1	0·09	3	0·28
Bingley	18,615	–	–	10	0·54	23	1·24	1	0·05	1	0·05	6	0·32
Birkenshaw..	2,599	–	–	6	2·31	4	1·54	4	1·54	–	–	3	1·15
Birstal	7,079	–	–	10	1·41	88	12·43	5	0·71	–	–	12	1·70
Bolton upon Dearne ..	9,970	–	–	22	2·21	69	6·92	1	0·10	3	0·30	10	1·00
Brighouse	19,748	–	–	20	1·01	36	1·82	2	0·10	1	0·05	5	0·25
Burley in Wharfedale ..	3,223	–	–	3	0·93	18	5·58	1	0·31	–	–	1	0·31
Calverley	3,366	–	–	5	1·49	2	0·59	1	0·30	–	–	1	0·30
Castleford	22,841	–	–	82	3·59	21	0·92	12	0·53	2	0·09	10	0·44
Clayton	4,677	–	–	1	0·21	4	0·86	3	0·64	1	0·21	–	–
Clayton West	1,856	–	–	–	–	–	–	–	–	–	–	1	0·54
Cudworth	6,820	–	–	7	1·03	5	0·73	–	–	–	–	10	1·47
Darfield	5,412	–	–	5	0·92	5	0·92	1	0·18	–	–	10	1·85
Darton	10,543	–	–	19	1·80	4	0·38	2	0·19	2	0·19	9	0·85
Denby and Cumberworth	3,619	–	–	10	2·76	1	0·28	–	–	–	–	1	0·28
Denholme	2,786	–	–	2	0·72	1	0·36	–	–	–	–	3	1·08
Dodworth	3,154	–	–	9	2·85	1	0·32	–	–	–	–	–	–
Doncaster	49,980	–	–	177	3·54	49	0·98	3	0·06	4	0·08	41	0·82
Drighlington	4,042	–	–	12	2·97	7	1·73	3	0·74	–	–	5	1·24
Earby	5,756	–	–	12	2·08	1	0·17	1	0·17	–	–	5	0·87
Elland..	10,719	–	–	46	4·29	11	1·03	–	–	–	–	6	0·56
Emley..	1,578	–	–	4	2·53	1	0·63	–	–	–	–	–	–

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Yorkshire, West Riding—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Farnley Tyas	460	–	–	–	–	–	–	–	–	–	–	–	–
Farsley	5,993	–	–	5	0·83	9	1·50	2	0·33	–	–	1	0·17
Featherstone	13,984	–	–	49	3·50	10	0·72	4	0·29	–	–	2	0·14
Flockton	1,362	–	–	4	2·94	–	–	–	–	–	–	1	0·73
Garforth	3,915	–	–	–	–	1	0·26	–	–	–	–	–	–
Gildersome	2,905	–	–	2	0·69	13	4·48	1	0·34	–	–	1	0·34
Golcar	9,990	–	–	7	0·70	4	0·40	3	0·30	–	–	5	0·50
Goole	18,398	–	–	14	0·76	59	3·21	1	0·05	1	0·05	14	0·76
Greasbrough	3,173	–	–	9	2·84	2	0·63	–	–	–	–	4	1·26
Greetland	4,285	–	–	4	0·93	5	1·17	4	0·93	1	0·23	3	0·70
Guiseley	4,916	–	–	2	0·41	21	4·27	–	–	1	0·20	–	
Gunthwaite and Ingbirchworth.	294	–	–	1	3·40	–	–	–	–	–	–	1	3·40
Handsworth	15,072	–	–	33	2·19	27	1·79	6	0·40	–	–	11	0·73
Harrogate	33,204	–	–	32	0·96	25	0·75	2	0·06	–	–	17	0·51
Haworth	6,348	–	–	17	2·68	1	0·16	1	0·16	–	–	2	0·32
Hebden Bridge	6,644	–	–	17	2·56	28	4·21	5	0·75	–	–	1	0·15
Heckmondwike	8,585	–	–	11	1·28	8	0·93	1	0·12	–	–	5	0·58
Hipperholme	4,874	–	–	1	0·21	3	0·62	–	–	–	–	1	0·21
Holme	342	–	–	6	17·54	–	–	–	–	–	–	–	–
Holmfirth	10,047	–	–	1	0·10	18	1·79	1	0·10	–	–	6	0·60
Honley	4,485	–	–	5	1·11	5	1·11	–	–	–	–	2	0 45
Horbury	7,611	–	–	7	0·92	45	5·91	–	–	–	–	1	0·13
Horsforth	9,148	–	–	22	2·40	28	3·06	–	–	–	–	7	0·77
Hoyland Nether	14,110	–	–	49	3·47	7	0·50	7	0·50	–	–	29	2·06
Hoyland Swaine	580	–	–	–	–	1	1·72	–	–	–	–	–	–
Hunsworth	1,294	–	–	2	1·55	–	–	1	0·77	–	–	1	0·77
Ilkley	7,835	–	–	25	3·19	10	1·28	2	0·26	–	–	4	0·51
Keighley	41,277	–	–	18	0·44	41	0·99	1	0·02	1	0·02	20	0·48
Kirkburton	3,328	–	–	4	1·20	1	0·30	–	–	–	–	4	1·20
Kirkheaton	2,509	–	–	2	0·80	1	0·40	–	–	–	–	–	–
Knaresborough	4,830	–	–	3	0·62	8	1·66	–	–	–	–	1	0·21
Knottingley	6,478	–	–	4	0·62	1	0·15	–	–	–	–	2	0·31
Lepton	3,043	–	–	2	0·66	2	0·66	2	0·66	1	0·33	–	–
Linthwaite	9,411	–	–	10	1·06	6	0·64	1	0·11	–	–	8	0·85
Luddenden Foot	2,811	–	–	6	2·13	7	2·49	1	0·36	–	–	4	1·42
Marsden	5,756	–	–	11	1·91	25	4·34	2	0·35	–	–	8	1·39
Meltham	4,758	–	–	2	0·42	1	0·21	–	–	–	–	–	–
Methley	4,472	–	–	1	0·22	2	0·45	–	–	–	–	3	0·67
Mexborough	14,210	–	–	20	1·41	16	1·13	2	0·14	3	0·21	12	0·84
Midgley	1,823	–	–	2	1·10	2	1·10	–	–	–	–	–	–
Mirfield	11,640	–	–	4	0·34	3	0·26	–	–	1	0·09	4	0·34
Monk Bretton	4,692	–	–	7	1·49	13	2·77	–	–	–	–	2	0·43
Morley	23,819	–	–	18	0·76	25	1·05	7	0·29	1	0·04	13	0·55
Mytholmroyd	3,937	–	–	2	0·51	6	1·52	2	0·51	–	–	3	0·76
New Mill	4,206	–	–	8	1·90	11	2·62	–	–	–	–	1	0·24
Normanton	14,995	–	–	34	2·27	9	0·60	1	0·07	1	0·07	21	1·40
Oakworth	3,852	–	–	5	1·30	2	0·52	–	–	–	–	3	0·78
Ossett	14,127	–	–	22	1·56	19	1·34	–	–	1	0·07	10	0·71
Otley	9,370	–	–	5	0·53	29	3·09	1	0·11	–	–	10	1·07
Oxenhope	2,319	–	–	–	–	–	–	–	–	–	–	–	–
Penistone	3,331	–	–	5	1·50	6	1·80	–	–	–	–	1	0·30
Pontefract	14,776	–	–	22	1·49	16	1·08	8	0·54	1	0·07	12	0·81
Pudsey	13,825	–	–	50	3·62	2	0·14	–	–	–	–	10	0·72
Queensbury	6,148	–	–	–	–	1	0·16	4	0·65	–	–	2	0·33
Rawdon	3,283	–	–	1	0·30	6	1·83	–	–	–	–	–	–
Rawmarsh	17,153	–	–	49	2·86	26	1·52	1	0·06	–	–	13	0·76
Ripon	8,159	–	–	18	2·21	31	3·80	1	0·12	1	0·12	7	0·86
Rishworth	839	–	–	–	–	–	–	–	–	–	–	–	–
Rothwell	14,386	–	–	16	1·11	14	0·97	3	0·21	1	0·07	11	0·76
Royston	6,021	–	–	10	1·66	12	1·99	–	–	–		1	0·17
Saddleworth	11.983	–	–	77	6·43	9	0·75	2	0·17	1	0·08	4	0·33
Scammonden	321	–	–	–	–	–	–	–	–	–	–	–	–
Selby	9,311	–	–	5	0·54	25	2·68	1	0·11	1	0·11	3	0·32
Shelf	2,424	–	–	2	0·83	1	0·41	–	–	–	–	–	–
Shelley	1,581	–	–	1	0·63	1	0·63	–	–	–	–	–	–
Shepley	1,714	–	–	3	1·75	–	–	–	–	–	–	1	0·58
Shipley	27,484	–	–	22	0·80	93	3·38	3	0·11	–	–	7	0·25

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Yorkshire, West Riding—*continued.*													
BOROUGHS AND URBAN DISTRICTS:—													
Silsden	4,947	–	–	13	2·63	1	0·20	–	–	–	–	4	0·81
Skelmanthorpe	3,611	–	–	1	0·28	1	0·28	1	0·28	–	–	2	0·55
Skipton	11,368	–	–	38	3·34	24	2·11	1	0·09	–	–	6	0·53
Slaithwaite	5,243	–	–	4	0·76	3	0·57	1	0·19	–	–	1	0·19
South Crosland	3,060	–	–	2	0·65	12	3·92	–	–	–	–	–	–
Southowram	2,332	–	–	2	0·86	2	0·86	–	–	–	–	2	0·86
Sowerby	2,940	–	–	3	1·02	4	1·36	–	–	–	–	1	0·34
Sowerby Bridge	11,386	–	–	9	0·79	6	0·53	–	–	–	–	9	0·79
Soyland	2,715	–	–	9	3·31	–	–	–	–	–	–	1	0·37
Spenborough	30,760	–	–	20	0·65	75	2·44	3	0·10	2	0·07	14	0·46
Springhead	4,590	–	–	6	1·31	5	1·09	–	–	–	–	3	0·65
Stainland with Old Lindley.	4,295	–	–	17	3·96	3	0·70	2	0·47	–	–	7	1·63
Stanley	14,047	–	–	11	0·78	17	1·21	–	–	–	–	14	1·00
Stocksbridge	7,689	–	–	57	7·41	3	0·39	–	–	1	0·13	3	0·39
Swinton	12,901	–	–	15	1·16	10	0·78	1	0·08	1	0·08	14	1·09
Thurlstone	2,617	–	–	7	2·67	3	1·15	–	–	1	0·38	4	1·53
Thurnscoe	4,306	–	–	12	2·79	29	6·73	–	–	–	–	8	1·86
Thurstonland	896	–	–	3	3·35	1	1·12	11	12·28	–	–	2	2·23
Tickhill	1,916	–	–	1	0·52	2	1·04	–	–	–	–	–	–
Todmorden	23,462	–	–	7	0·30	21	0·90	22	0·94	3	0·13	27	1·15
Wath-upon-Dearne ..	12,047	–	–	51	4·23	9	0·75	3	0·25	2	0·17	22	1·83
Whitley Upper	799	–	–	–	–	–	–	–	–	–	–	–	–
Whitwood	5,245	–	–	14	2·67	5	0·95	2	0·38	–	–	2	0·38
Wombwell	17,969	–	–	17	0·95	13	0·72	1	0·06	–	–	12	0·67
Worsborough	12,976	–	–	23	1·77	11	0·85	1	0·08	–	–	3	0·23
Yeadon	7,207	–	–	14	1·94	29	4·02	1	0·14	–	–	1	0·14
RURAL DISTRICTS:—													
Barnsley	3,887	–	–	10	2·57	1	0·26	–	–	1	0·26	4	1·03
Bishopthorpe	2,044	–	–	4	1·96	–	–	1	0·49	–	–	–	–
Bowland	5,156	–	–	1	0·19	–	–	1	0·19	–	–	2	0·39
Doncaster	33,111	–	–	83	2·51	48	1·45	12	0·36	3	0·09	19	0·57
Goole	7,880	–	–	1	0·13	18	2·28	15	1·90	–	–	1	0·13
Great Ouseburn	10,335	–	–	15	1·45	6	0·58	3	0·29	–	–	3	0·29
Halifax	5,923	–	–	5	0·84	7	1·18	1	0·17	–	–	1	0·17
Hemsworth	43,476	–	–	199	4·58	58	1·33	5	0·12	1	0·02	24	0·55
Hunslet	7,850	–	–	8	1·02	8	1·02	1	0·13	1	0·13	4	0·51
Keighley	6,432	–	–	8	1·24	5	0·78	2	0·31	–	–	1	0·16
Kiveton Park	13,950	–	–	36	2·58	19	1·36	1	0·07	–	–	9	0·65
Knaresborough	8,167	–	–	13	1·59	22	2·69	7	0·86	–	–	–	–
Pateley Bridge	6,440	–	–	1	0·16	–	–	–	–	–	–	2	0·31
Penistone	5,307	–	–	14	2·64	6	1·13	4	0·75	1	0·19	3	0·57
Pontefract	16,093	–	–	50	3·11	20	1·24	1	0·06	–	–	5	0·31
Ripon	5,283	–	–	3	0·57	7	1·33	–	–	–	–	2	0·38
Rotherham	31,598	–	–	109	3·45	50	1·58	3	0·09	5	0·16	20	0·63
Sedbergh	3,399	–	–	2	0·59	3	0·88	2	0·59	–	–	1	0·29
Selby	5,572	–	–	5	0·90	2	0·36	1	0·18	–	–	–	–
Settle	13,568	–	–	7	0·52	5	0·37	–	–	1	0·07	6	0·44
Skipton	17,844	–	–	18	1·01	3	0·17	–	–	–	–	2	0·11
Tadcaster	26,757	–	–	84	3·14	14	0·52	18	0·67	–	–	11	0·41
Thorne	8,610	–	–	20	2·32	11	1·28	2	0·23	–	–	16	1·86
Todmorden	4,408	–	–	4	0·91	8	1·82	–	–	–	–	4	0·91
Wakefield	16,084	–	–	72	4·48	16	0·99	7	0·44	–	–	12	0·75
Wetherby	13,885	–	–	32	2·30	11	0·79	–	–	–	–	7	0·50
Wharfedale	7,063	–	–	5	0·71	4	0·57	2	0·28	–	–	12	1·70
Wortley	29,520	–	–	68	2·30	25	0·85	1	0·03	1	0·03	6	0·20
County of Anglesey.													
ADMINISTRATIVE COUNTY	48,029	–	–	81	1·69	41	0·85	22	0·46	2	0·04	6	0·12
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	18,018	–	–	31	1·72	28	1·55	2	0·11	–	–	–	–
AGGREGATE OF RURAL DISTRICTS.	30,011	–	–	50	1·67	13	0·43	20	0·67	2	0·07	6	0·20

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Anglesey— *continued*													
BOROUGHS AND URBAN DISTRICTS:—													
Amlwch	2,625	–	–	3	1·14	–	–	–	–	–	–	–	–
Beaumaris	1,745	–	–	–	–	–	–	–	–	–	–	–	–
Holyhead	10,525	–	–	21	2·00	24	2·28	1	0·10	–	–	–	–
Llangefni	1,580	–	–	4	2·53	1	0·63	–	–	–	–	–	–
Menai Bridge	1,543	–	–	3	1·94	3	1·94	1	0·65	–	–	–	–
RURAL DISTRICTS:—													
Aethwy	8,146	–	–	12	1·47	3	0·37	18	2·21	1	0·12	–	–
Dwyran	2,874	–	–	2	0·70	–	–	–	–	–	–	1	0·35
Twrcelyn	8,718	–	–	17	1·95	1	0·11	–	–	1	0·11	3	0·34
Valley..	10,273	–	–	19	1·85	9	0·84	2	0·19	–	–	2	0·19
County of Brecknock.													
ADMINISTRATIVE COUNTY	56,175	–	–	178	3·17	39	0·69	19	0·34	2	0·04	14	0·25
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	15,995	–	–	33	2·06	12	0·75	14	0·88	–	–	2	0·13
AGGREGATE OF RURAL DISTRICTS.	40,180	–	–	145	3·61	27	0·67	5	0·12	2	0·05	12	0·30
BOROUGHS AND URBAN DISTRICTS:—													
Brecknock	5,064	–	–	16	3·16	7	1·38	–	–	–	–	–	–
Brynmawr	7,287	–	–	12	1·65	2	0·27	14	1·92	–	–	1	0·14
Builth Wells	1,528	–	–	3	1·96	3	1·96	–	–	–	–	–	–
Hay	1,342	–	–	1	0·75	–	–	–	–	–	–	–	–
Llanwrtyd	774	–	–	1	1 29	–	–	–	–	–	–	1	1·29
RURAL DISTRICTS:—													
Brecknock	8,708	–	–	20	2·30	1	0·11	–	–	–	–	–	–
Builth	3,938	–	–	1	0·25	2	0·51	–	–	1	0·25	–	–
Crickhowell..	7,293	–	–	32	4·39	4	0·55	5	0·69	1	0·14	1	0·14
Hay	3.118	–	–	8	2·57	4	1·28	–	–	–	–	1	0·32
*Llanwrthwl (parish) ..	372	–	–	–	–	–	–	–	–	–	–	–	–
Vaynor and Penderyn ..	5,393	–	–	18	3·34	1	0·19	–	–	–	–	3	0·56
†Ystradfellte (parish) ..	630	–	–	3	4·76	–	–	–	–	–	–	–	–
Ystradgynlais	10,728	–	–	63	5·87	15	1·40	–	–	–	–	7	0·65
County of Cardigan.													
ADMINISTRATIVE COUNTY	55,270	–	–	61	1·10	66	1·19	4	0·07	–	–	6	0·11
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	14,875	–	–	20	1·34	41	2·76	2	0·13	–	–	4	0·27
AGGREGATE OF RURAL DISTRICTS.	40,395	–	–	41	1·01	25	0·62	2	0·05	–	–	2	0·05
BOROUGHS AND URBAN DISTRICTS:—													
Aberayron	1,317	–	–	1	0·76	4	3·04	1	0·76	–	–	–	–
Aberystwyth	7,404	–	–	5	0·68	31	4·19	–	–	–	–	1	0·14
Cardigan	3.309	–	–	12	3·63	2	0·60	–	–	–	–	3	0·91
Lampeter	1,621	–	–	1	0·62	–	–	–	–	–	–	–	–
New Quay	1,224	–	–	1	0·82	4	3·27	1	0·82	–	–	–	–
RURAL DISTRICTS:—													
Aberayron	7,469	–	–	6	0·80	7	0·94	1	0·13	–	–	–	–
Aberystwyth	11,803	–	–	12	1·02	2	0·17	1	0·08	–	–	1	0·08
Cardigan	2,966	–	–	–	–	1	0·34	–	–	–	–	–	–
Lampeter	3,302	–	–	11	3·33	4	1·21	–	–	–	–	1	0·30
Llandyssul	7,567	–	–	5	0·66	9	1·18	–	–	–	–	–	–
‡Scybor-y-coed (parish) ..	382	–	–	2	5·24	–	–	–	–	–	–	–	–
Tregaron	6,906	–	–	5	0·72	2	0·29	–	–	–	–	–	–

* This parish is administered by the Rural District Council of Rhayader (Radnor).
† This parish is administered by the Rural District Council of Neath (Glamorgan).
‡ This parish is administered by the Rural District Council of Machynlleth (Montgomery).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Carmarthen.													
ADMINISTRATIVE COUNTY	160,587	–	–	583	3·63	158	0·98	18	0·11	15	0·09	68	0·42
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	65,593	–	–	308	4·70	54	0·82	3	0·05	11	0·17	27	0·41
AGGREGATE OF RURAL DISTRICTS.	94,994	–	–	275	2·89	104	1·09	15	0·16	4	0·04	41	0·43
BOROUGHS AND URBAN DISTRICTS:—													
Ammanford..	6,320	–	–	31	4·91	8	1·27	–	–	–	–	3	0·47
Burry Port	5,586	–	–	16	2·86	11	1·97	–	–	1	0·18	3	0·54
Carmarthen..	8,376	–	–	26	3·10	10	1·19	–	–	1	0·12	2	0·24
Cwmamman	4,832	–	–	67	13·87	1	0·21	–	–	–	–	1	0·21
Kidwelly	2,934	–	–	1	0·34	1	0·34	–	–	–	–	–	–
Llandilo	1,659	–	–	23	13·86	6	3·62	–	–	–	–	–	–
Llandovery	1,691	–	–	–	–	3	1·77	–	–	–	–	–	–
Llanelly	33,396	–	–	144	4·31	14	0·42	3	0·09	9	0·27	18	0·54
Newcastle Emlyn.. ..	799	–	–	–	–	–	–	–	–	–	–	–	–
RURAL DISTRICTS:—													
Carmarthen.. . ..	23,814	–	–	49	2·06	13	0·55	4	0·17	1	0·04	5	0·21
Llandilofawr	20,185	–	–	115	5·70	53	2·63	3	0·15	1	0·05	7	0·35
Llandovery	6,769	–	–	3	0·44	6	0·89	–	–	–	–	–	–
Llanelly	29,778	–	–	96	3·22	20	0·67	7	0·24	2	0·07	24	0·81
Llanybyther	3,462	–	–	6	1·73	3	0·87	–	–	–	–	1	0·29
Newcastle in Emlyn ..	6,194	–	–	2	0·32	7	1·13	1	0·16	–	–	1	0·16
Whitland	4,792	–	–	4	0·83	2	0·42	–	–	–	–	3	0·63
County of Carnarvon.													
ADMINISTRATIVE COUNTY	112,115	–	–	110	0·98	152	1·36	17	0·15	4	0·04	39	0·35
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	52,900	–	–	61	1·15	67	1·27	13	0·25	3	0·06	21	0·40
AGGREGATE OF RURAL DISTRICTS.	59,215	–	–	49	0·83	85	1·44	4	0·07	1	0·02	18	0·30
BOROUGHS AND URBAN DISTRICTS:—													
Bangor	9,720	–	–	36	3·70	13	1·34	6	0·62	1	0·10	4	0·41
Bethesda	3,897	–	–	1	0·26	–	–	–	–	–	–	1	0·26
Bettws y Coed	792	–	–	–	–	4	5·05	–	–	–	–	–	–
Carnarvon	8,072	–	–	2	0·25	21	2·60	–	–	–	–	8	0·99
Conway	4,930	–	–	3	0·61	13	2·64	5	1·01	1	0·20	1	0·20
Criccieth	1,465	–	–	8	5·46	–	–	–	–	–	–	3	2·05
Llandudno	10,066	–	–	7	0·70	12	1·19	2	0·20	1	0·10	1	0·10
Llanfairfechan	2,840	–	–	3	1·06	–	–	–	–	–	–	–	–
Penmaenmawr	3,496	–	–	1	0·29	–	–	–	–	–	–	2	0·57
Pwllheli	3,484	–	–	–	–	1	0·29	–	–	–	–	–	–
Portmadoc	4,138	–	–	–	–	3	0·72	–	–	–	–	1	0·24
RURAL DISTRICTS:—													
Conway	7,197	–	–	10	1·39	14	1·95	–	–	–	–	2	0·28
Geirionydd	3,727	–	–	7	1·88	7	1·88	–	–	–	–	–	–
Glaslyn	2,985	–	–	4	1·34	–	–	1	0·34	–	–	1	0·34
Gwyrfai	23,445	–	–	22	0·94	21	0·90	–	–	1	0·04	14	0·60
Lleyn	16,214	–	–	4	0·25	42	2·59	1	0·06	–	–	–	–
Ogwen	5,647	–	–	2	0·35	1	0·18	2	0·35	–	–	1	0·18
County of Denbigh.													
ADMINISTRATIVE COUNTY.	136,955	–	–	235	1·72	145	1·06	5	0·04	8	0·06	49	0·36
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	44,584	–	–	43	0·96	50	1·12	2	0·04	2	0·04	14	0·31
AGGREGATE OF RURAL DISTRICTS.	92,371	–	–	192	2·08	95	1·03	3	0·03	6	0·06	35	0·38
BOROUGHS AND URBAN DISTRICTS:—													
Abergele and Pensarn ..	2,218	–	–	–	–	–	–	–	–	–	–	1	0·45
Colwyn Bay and Colwyn	12,346	–	–	18	1·46	9	0·73	1	0·08	–	–	3	0·24
Denbigh	5,364	–	–	2	0·37	28	5·22	1	0·19	–	–	9	1·68
Llangollen	2,939	–	–	1	0·34	–	–	–	–	–	–	–	–
Llanrwst	2,172	–	–	1	0·46	1	0·46	–	–	–	–	1	0·46
Ruthin	2,378	–	–	–	–	1	0·42	–	–	–	–	–	–
Wrexham	17,172	–	–	21	1·22	11	0·64	–	–	2	0·12	–	–

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Denbigh—*continued.*													
RURAL DISTRICTS :—													
Chirk	4,261	–	–	2	0·47	1	0·23	–	–	1	0·23	1	0·23
*Glan Conway and Llanelian (parishes).	1,713	–	–	–	–	–	–	–	–	–	–	–	–
Llangollen	3,491	–	–	3	0·86	–	–	–	–	–	–	–	–
Llanrwst	4,070	–	–	3	0·74	11	2·70	–	–	1	0·25	6	1·47
Llansilin	2,919	–	–	2	0·69	–	–	–	–	1	0·34	2	0·69
Ruthin	8,290	–	–	6	0·72	6	0·72	–	–	–	–	–	–
St. Asaph (Denbigh) ..	7,285	–	–	6	0·82	13	1·78	–	–	–	–	4	0·55
Uwchaled	2,208	–	–	1	0·45	1	0·45	–	–	–	–	1	0·45
Wrexham	58,134	–	–	169	2·91	63	1·08	3	0·05	3	0·05	21	0·36
County of Flint.													
ADMINISTRATIVE COUNTY	90,478	–	–	190	2·10	293	3·24	12	0·13	4	0·04	44	0·49
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	34,546	–	–	52	1·51	119	3·44	3	0·09	–	–	17	0·49
AGGREGATE OF RURAL DISTRICTS.	55,932	–	–	138	2·47	174	3·11	9	0·16	4	0·07	27	0·48
BOROUGHS AND URBAN DISTRICTS :—													
Buckley	6,349	–	–	–	–	42	6·62	–	–	–	–	4	0·63
Connah's Quay	4,478	–	–	25	5·58	7	1·56	–	–	–	–	2	0·45
Flint	5,287	–	–	18	3·40	9	1·70	2	0·38	–	–	4	0·76
Holywell	2,472	–	–	–	–	2	0·81	1	0·40	–	–	1	0·40
Mold	4,258	–	–	2	0·47	13	3·05	–	–	–	–	1	0·23
Prestatyn	2,395	–	–	2	0·84	–	–	–	–	–	–	–	–
Rhyl	9,307	–	–	5	0·54	46	4·94	–	–	–	–	5	0·54
RURAL DISTRICTS :—													
Hawarden	21,602	–	–	88	4.07	72	3·33	1	0·05	4	0·19	11	0·51
Holywell	23,269	–	–	32	1·38	90	3·87	7	0·30	–	–	14	0·60
Overton	4,784	–	–	8	1·67	2	0·42	–	–	–	–	2	0·42
St. Asaph	6,277	–	–	10	1·59	10	1·59	1	0·16	–	–	–	–
County of Glamorgan.													
ADMINISTRATIVE COUNTY	752,700	10	0·01	2,313	3·07	1,148	1·53	138	0·18	50	0·07	345	0·46
COUNTY BOROUGHS :—													
Cardiff	180,341	49	0·27	479	2·66	372	2·06	26	0·14	9	0·05	90	0·50
Merthyr Tydfil	74,387	–	–	120	1·61	31	0·42	17	0·23	10	0·13	41	0·55
Swansea	108,068	–	–	206	1·91	111	1·03	6	0·06	41	0·38	59	0·55
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	539,417	9	0·02	1,667	3·09	810	1·50	103	0·19	31	0·06	263	0·49
AGGREGATE OF RURAL DISTRICTS.	213,283	1	0·00	646	3·03	338	1·58	35	0·16	19	0·09	82	0·38
BOROUGHS AND URBAN DISTRICTS :—													
Aberavon	12,344	–	–	21	1·70	2	0·16	2	0·16	–	–	4	0·32
Aberdare	50,282	–	–	156	3·10	51	1·01	4	0·08	3	0·06	20	0·40
Barry	34,722	2	0·06	141	4·06	119	3·43	8	0·23	1	0·03	28	0·81
Bridgend	7,435	–	–	24	3·23	10	1·34	–	–	–	–	1	0·13
Briton Ferry	8,295	–	–	27	3·25	4	0·48	1	0·12	–	–	–	–
Caerphilly	33,017	–	–	196	5·94	90	2·73	7	0·21	1	0·03	15	0·45
Cowbridge	993	–	–	1	1·01	1	1·01	–	–	–	–	–	–
Gelligaer	36,843	–	–	223	6·05	41	1·11	2	0·05	–	–	11	0·30
Glyncorwg	9,392	–	–	13	1·38	11	1·17	–	–	1	0·11	3	0·32
Maesteg	26,012	–	–	118	4·54	53	2·04	–	–	1	0·04	10	0·38
Margam	15,269	–	–	33	2·16	19	1·24	1	0·07	–	–	10	0·65
Mountain Ash	40,390	–	–	132	3·27	111	2·75	7	0·17	6	0·15	27	0·67
Neath	16,085	–	–	73	4·54	34	2·11	3	0·19	3	0·19	6	0·37
Ogmore and Garw ..	27,382	–	–	83	3·03	44	1·61	8	0·29	2	0·07	16	0·58
Oystermouth	6,593	–	–	7	1·06	8	1·21	3	0·46	–	–	13	1·97
Penarth	15,335	7	0·46	37	2·41	29	1·89	–	–	–	–	1	0·07
Pontypridd	41,381	–	–	48	1·16	48	1·16	16	0·39	3	0·07	34	0·82
Porthcawl	4,274	–	–	8	1·87	1	0·23	–	–	–	–	–	–
Rhondda	153,373	–	–	326	2·13	134	0·87	41	0·27	10	0·07	64	0·42
RURAL DISTRICTS :—													
Cowbridge	8,046	–	–	9	1·12	12	1·49	1	0·12	–	–	13	1·62
Gower	8,514	–	–	16	1·88	7	0·82	–	–	2	0·23	2	0·23

* These parishes are administered by the Rural District Council of Conway (Carnarvon).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

—	Estimated Civil Population in the middle of 1916.	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Glamorgan —*continued.*													
RURAL DISTRICTS :—													
Llandaff and Dinas Powis	35,819	1	0·03	81	2·26	59	1·65	1	0·03	2	0·06	5	0·14
Llantrisant and Llantwit Fardre.	20,797	–	–	72	3·46	67	3·22	4	0·19	–	–	6	0·29
Neath	41,805	–	–	144	3·44	44	1·05	21	0·50	5	0·12	16	0·38
Penybont	20,522	–	–	73	3·56	47	2·29	3	0·15	1	0·05	13	0·63
Pontardawe..	31,811	–	–	77	2·42	20	0·63	3	0·09	2	0·06	10	0·31
Swansea	45,969	–	–	174	3·79	82	1·78	2	0·04	4	0·09	17	0·37
County of Merioneth.													
ADMINISTRATIVE COUNTY	40,432	–	–	46	1·14	112	2·77	2	0·05	–	–	36	0·89
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	17,419	–	–	17	0·98	59	3·39	–	–	–	–	34	1·95
AGGREGATE OF RURAL DISTRICTS.	23,013	–	–	29	1·26	53	2·30	2	0·09	–	–	2	0·09
BOROUGHS AND URBAN DISTRICTS :—													
Bala	1,300	–	–	2	1·54	–	–	–	–	–	–	–	–
Barmouth	2,180	–	–	–	–	–	–	–	–	–	–	–	–
Dolgelly	1,836	–	–	5	2·72	–	–	–	–	–	–	–	–
Festiniog	7,619	–	–	9	1·18	59	7·74	–	–	–	–	33	4·33
Mallwyd	736	–	–	–	–	–	–	–	–	–	–	–	–
Towyn	3,748	–	–	1	0·27	–	–	–	–	–	–	1	0·27
RURAL DISTRICTS :—													
Deudraeth	6,916	–	–	2	0·29	28	4·05	1	0·14	–	–	–	–
Dolgelly	7,466	–	–	11	1·47	3	0·40	1	0·13	–	–	1	0·13
Edeirnion	4,502	–	–	1	0·22	22	4·89	–	–	–	–	1	0·22
Penllyn	3,736	–	–	14	3·75	–	–	–	–	–	–	–	–
*Pennal (parish)	393	–	–	1	2·54	–	–	–	–	–	–	–	–
County of Monmouth. ADMINISTRATIVE COUNTY	316,081	1	0·00	1750	5·54	257	0·81	98	0·31	13	0·04	127	0·40
COUNTY BOROUGH :— Newport	79,287	3	0·04	218	2·75	130	1·64	12	0·15	5	0·06	24	0·30
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	274,906	–	–	1638	5·96	219	0·80	90	0·33	12	0·04	120	0·44
AGGREGATE OF RURAL DISTRICTS.	41,175	1	0·02	112	2·72	38	0·92	8	0·19	1	0·02	7	0·17
BOROUGHS AND URBAN DISTRICTS :—													
Abercarn	18,022	–	–	106	5·88	7	0·39	4	0·22	1	0·06	1	0·06
Abergavenny	7,812	–	–	26	3·33	1	0·13	–	–	–	–	3	0·38
Abersychan	25,046	–	–	221	8·82	19	0·76	3	0·12	1	0·04	14	0·56
Abertillery	35,998	–	–	255	7·08	32	0·89	3	0·08	1	0·03	8	0·22
Bedwas and Machen ..	7,235	–	–	20	2·76	14	1·94	1	0·14	1	0·14	1	0·14
Bedwellty	26,625	–	–	81	3·04	31	1·16	4	0·15	–	–	17	0·64
Blaenavon	12,028	–	–	103	8·56	1	0·08	2	0·17	1	0·08	3	0·25
Caerleon	1,692	–	–	3	1·77	4	2·36	1	0·59	–	–	2	1·18
Chepstow	2,531	–	–	3	1·19	1	0·40	–	–	–	–	–	–
Ebbw Vale	31,204	–	–	431	13·81	16	0·51	30	0·96	2	0·06	27	0·87
Llanfrechfa Upper ..	4,351	–	–	12	2·76	3	0·69	–	–	–	–	1	0·23
Llantarnam	6,179	–	–	2	0·32	2	0·32	1	0·16	1	0·16	–	–
Monmouth	4,468	–	–	9	2·01	1	0·22	–	–	–	–	–	–
Mynyddislwyn	11,937	–	–	45	3·77	9	0·75	–	–	–	–	6	0·50
Nantyglo and Blaina ..	14,801	–	–	62	4·19	11	0·74	10	0·68	–	–	–	–
Panteg	9,907	–	–	53	5·35	5	0·50	–	–	–	–	1	0·10
Pontypool	5,807	–	–	26	4·48	5	0·86	4	0·69	–	–	2	0·34
Rhymney	10,538	–	–	10	0·95	11	1·04	1	0·09	1	0·09	9	0·85
Risca	15,031	–	–	54	3·59	7	0·47	1	0·07	–	–	–	–
Tredegar	22,464	–	–	116	5·16	39	1·74	25	1·11	3	0·13	25	1·11
Usk	1,230	–	–	–	–	–	–	–	–	–	–	–	–
RURAL DISTRICTS :—													
Abergavenny	7,566	–	–	22	2·91	9	1·19	8	1·06	–	–	1	0·13
Chepstow	7,809	–	–	33	4·23	7	0·90	–	–	–	–	1	0·13
Magor	4,843	–	–	7	1·45	3	0·62	–	–	–	–	3	0·62
Monmouth	6,134	–	–	37	6·03	3	0·49	–	–	–	–	–	–
Pontypool	4,798	–	–	1	0·21	–	–	–	–	–	–	–	–
St. Mellons	10,925	1	0·10	12	1·20	16	1·60	–	–	1	0·10	2	0·20

* This parish is administered by the Rural District Council of Machynlleth (Montgomery).

NOTIFICATIONS OF INFECTIOUS DISEASE AND ATTACK-RATES, 1916—*continued.*

——	Estimated Civil Population in the middle of 1916	Small-pox.		Scarlet Fever.		Diphtheria.		Enteric Fever.		Puerperal Fever.		Erysipelas.	
		Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.	Cases.	Rate.
County of Montgomery													
ADMINISTRATIVE COUNTY.	48,553	–	–	73	1·50	31	0·64	5	0·10	1	0·02	17	0·35
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	17,024	–	–	24	1·41	8	0·47	2	0·12	1	0·06	10	0·59
AGGREGATE OF RURAL DISTRICTS.	31,529	–	–	49	1·55	23	0·73	3	0·10	–	–	7	0·22
BOROUGHS AND URBAN DISTRICTS:—													
Llanfyllin	1,385	–	–	–	–	–	–	–	–	1	0·72	2	1·44
Llanidloes	2,372	–	–	9	3·79	2	0·84	–	–	–	–	1	0·42
Machynlleth	1,756	–	–	5	2·85	1	0·57	–	–	–	–	–	–
Montgomery	871	–	–	–	–	–	–	–	–	–	–	1	1·15
Newtown and Llanllwchaiarn.	5,355	–	–	9	1·68	–	–	1	0·19	–	–	3	0·56
Welshpool	5,285	–	–	1	0·19	5	0·95	1	0·19	–	–	3	0·57
RURAL DISTRICTS:—													
Forden	5,190	–	–	4	0·77	4	0·77	–	–	–	–	4	0·77
Llanfyllin	11,864	–	–	32	2·70	13	1·10	–	–	–	–	1	0·08
Machynlleth	3,780	–	–	4	1·06	5	1·32	–	–	–	–	1	0·26
Newtown and Llanidloes	10,695	–	–	9	0·84	1	0·09	3	0·28	–	–	1	0·09
County of Pembroke.													
ADMINISTRATIVE COUNTY	84,552	–	–	163	1·93	100	1·18	16	0·19	4	0·05	21	0·25
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	36,860	–	–	83	2·25	54	1·47	9	0·24	3	0·08	12	0·33
AGGREGATE OF RURAL DISTRICTS.	47,692	–	–	80	1·68	46	0·96	7	0·15	1	0·02	9	0·19
BOROUGHS AND URBAN DISTRICTS:—													
Fishguard	2,731	–	–	18	6·59	2	0·73	1	0·37	2	0·73	–	–
Haverfordwest	5,320	–	–	4	0·75	11	2·07	1	0·19	1	0·19	4	0·75
* Milford Haven	6,528	–	–	15	2·30	17	2·60	4	0·61	–	–	4	0·61
Narberth	1,110	–	–	–	–	–	–	–	–	–	–	–	–
Neyland	2,507	–	–	10	3·99	6	2·39	3	1·20	–	–	1	0·40
Pembroke	14,868	–	–	34	2·29	15	1·01	–	–	–	–	3	0·20
Tenby	3,796	–	–	2	0·53	3	0·79	–	–	–	–	–	–
RURAL DISTRICTS:—													
Haverfordwest	19,712	–	–	34	1·72	16	0·81	–	–	1	0·05	7	0·36
Llanfyrnach	2,299	–	–	–	–	1	0·43	–	–	–	–	–	–
Narberth	10,187	–	–	18	1·77	8	0·79	–	–	–	–	1	0·10
Pembroke	7,791	–	–	18	2·31	10	1·28	4	0·51	–	–	1	0·13
St. Dogmells	7,703	–	–	10	1·30	11	1·43	3	0·39	–	–	–	–
County of Radnor.													
ADMINISTRATIVE COUNTY	20,917	–	–	29	1·39	4	0·19	–	–	1	0·05	4	0·19
AGGREGATE OF BOROUGHS AND URBAN DISTRICTS.	5,472	–	–	11	2·01	–	–	–	–	–	–	–	–
AGGREGATE OF RURAL DISTRICTS.	15,445	–	–	18	1·17	4	0·26	–	–	1	0·06	4	0·26
BOROUGHS AND URBAN DISTRICTS:—													
Knighton	1,615	–	–	–	–	–	–	–	–	–	–	–	–
Llandrindod Wells ..	2,796	–	–	8	2·86	–	–	–	–	–	–	–	–
Presteign	1,061	–	–	3	2·83	–	–	–	–	–	–	–	–
RURAL DISTRICTS:—													
Colwyn	1,883	–	–	1	0·53	1	0·53	–	–	–	–	–	–
Knighton	4,240	–	–	–	–	3	0·71	–	–	1	0·24	2	0·47
New Radnor	2,537	–	–	6	2·36	–	–	–	–	–	–	–	–
Painscastle	2,077	–	–	1	0·48	–	–	–	–	–	–	2	0·96
Rhayader	4,708	–	–	10	2·12	–	–	–	–	–	–	–	–

*1 Case of Typhus Fever was notified.

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6. Dr. Lewis's Report on Organisms resembling Meningococci in the Naso-Pharynx of Non-Contacts.
7. Dr. Nabarro's Report upon Meningococcus-like Organisms occurring in the Naso-Pharynx of Children and upon Meningococci of Spinal origin.

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CONTENTS.

CEREBRO-SPINAL FEVER.

Preliminary Memorandum by the Medical Officer of the Board.

The appearance of epidemic cerebro-spinal fever in this country at the beginning of 1915 has given rise to a large number of investigations. The bacteriological work done for the Army authorities during 1915 has been ably summarised by a Special Advisory Committee, appointed by the Medical Research Committee, in a report published early in 1916. Shortly afterwards the Board issued a report on inquiries made during 1915 by their own investigators, who dealt with the subject as a problem affecting the civilian population. This was followed by a further report from the bacteriologists working for the forces, published by the Medical Research Committee early in the present year, in which they have put together the results of their investigations up to the end of 1916. The present volume contains the observations made by the Board's investigators since the issue of their former report.

It is known that the meningococcus is a delicate organism which is incapable of growth or survival at a temperature much below that of the human body. It is found in the human naso-pharynx, where it may grow readily, and is transmitted from person to person in droplets expelled by forcible expiration of the carrier and inhaled by those in close propinquity. It may also be conveyed from mouth to mouth either by direct contact, as in kissing, or, possibly, through the intermediation of some article infected by the mouth of the carrier. There is no evidence of more distant or more indirect mode of transmission. The presence of the meningococcus in the naso-pharynx does not necessarily lead to meningitis; on the contrary, the meningococcus often behaves as a harmless saprophyte, and may be found in this condition even in non-epidemic periods.

For evidence on this last point one must turn to records prior to the epidemic of 1915-17.

As pointed out by Dr. Eastwood in his last report, Kutscher, working in Berlin in the winter of 1905-6, when the town had remained completely free from both epidemic and sporadic cerebro-spinal fever for a period of six months, examined the naso-pharynx of 56 persons, and found that cultures from four were indistinguishable from the meningococcus "morphologically, culturally, and in their immunity reactions." Dr. Eastwood has also quoted the work of Mayer and his colleagues at Munich in 1910, during what is stated to have been an epidemic-free period*; they took swabs from 9,111 men in garrison and found 158 carriers (1·7 per cent.). None of these men developed

* Dr. Bruce Low records that "from 1907 to 1911 there were in Munich 142 cases and 67 deaths. . . . but there have been no epidemics".

cerebro-spinal fever. Captain Flack† also quotes these figures as an example of carrier percentage in epidemic-free times, and adds similar figures obtained in 1908 by Schumacher and Aumann, who found just over 2 per cent. of carriers in 1,500 soldiers.

As the technique for isolating the meningococcus from the naso-pharynx has improved in recent years, these figures may be regarded as possibly below the true percentage. To realise their significance they must be taken in conjunction with the observation, which has been confirmed repeatedly, that the meningococcus does not usually persist in the naso-pharynx of a carrier for more than two or three weeks. Hence the discovery of only a small percentage of carriers indicates that a large proportion of the population harbour the meningococcus at one time or another, even during a non-epidemic season. The absence of an epidemic, therefore, does not mean the absence of the meningococcus; this fact is corroborated by the occurrence of sporadic cases of meningococcal meningitis during non-epidemic periods.

Bearing the above facts in mind, we may proceed to consider the circumstances under which epidemics occur.

Prevalence.—Cerebro-spinal fever has been compulsorily notifiable throughout England and Wales from September 1st, 1912, and the number of cases of this disease notified in recent years has been as follows:—

1912 (part of year)	272
1913	305
1914	315
1915	2,566
1916	1,306
1917 (to June 30th)	1,085

The above cases relate only to the civilian population. Among soldiers 1,136 cases were reported as cerebro-spinal fever in England and Wales in 1915 and 893 in 1916. The incidence of notified cases week by week from September 26th, 1914, to June 30th, 1917, is shown on the chart on the next page, on which the military as well as the civilian cases are recorded. The chart gives the number of cases as originally notified. In a not inconsiderable number of instances, the diagnosis was subsequently revised; but changes on this score would not materially affect the general course of the curve in the chart.

Mortality.—Corresponding with the increase in the number of cases, a great increase in the mortality registered as due to cerebro-spinal fever has occurred.

In the five years 1901-5, the total deaths from cerebro-spinal fever in England and Wales numbered 395, or an average of 79 annually. In the next five years the annual number of deaths averaged 122. In the three following years the annual deaths averaged 146; in 1914 they had increased to 194, in 1915 to 1,974, and in 1916 they were 369.

† Medical Research Committee. Special Report Series, No. 3, 1917.

In the recent epidemic England and Wales has suffered much less severely than other countries in which cerebro-spinal fever has become epidemic.

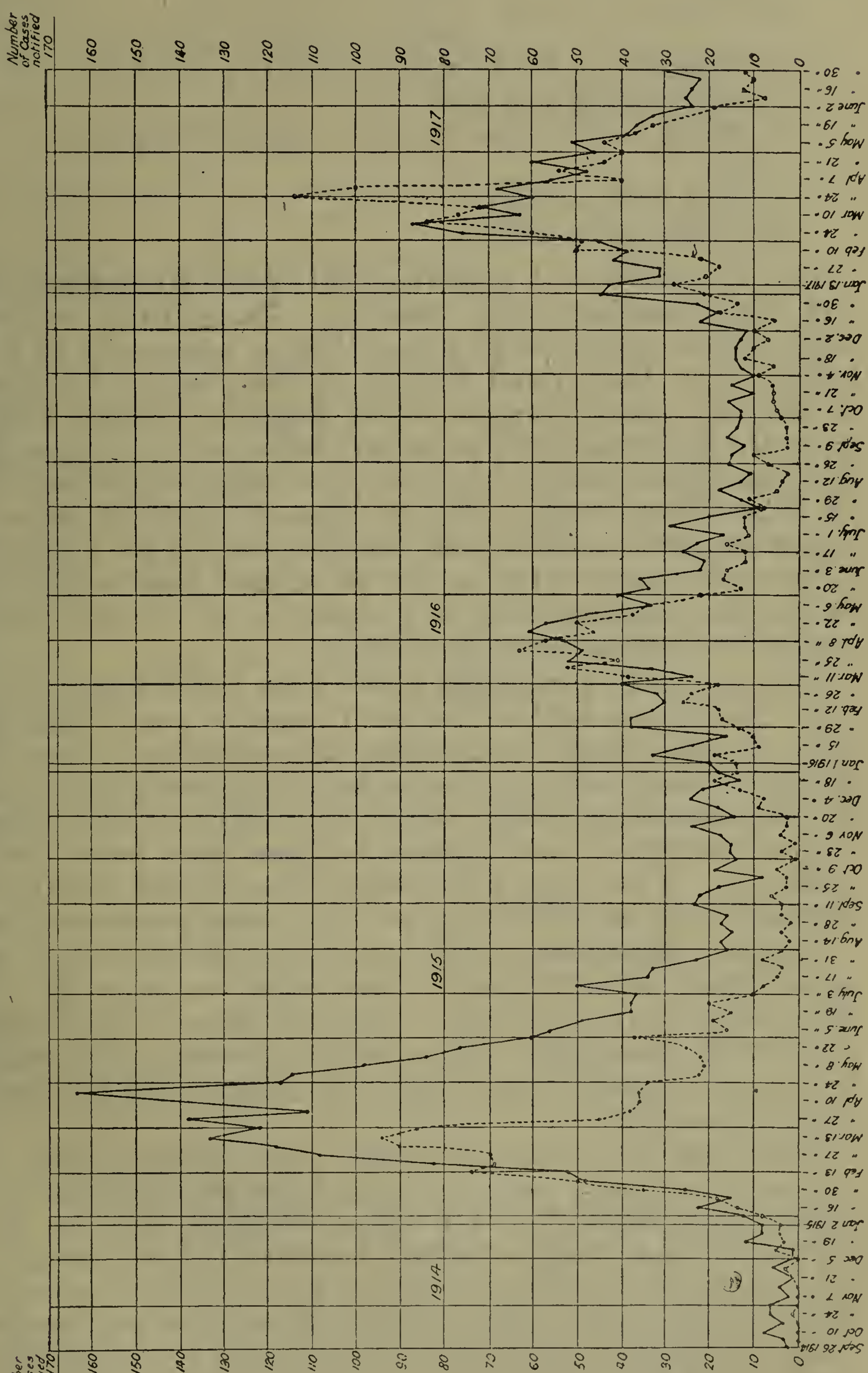


FIG. 1.—*Cerebro-spinal Fever in England and Wales.*
Cases notified week by week, 26th September, 1914, to 30th June, 1917.
Continuous line = civilian cases; dotted line = military cases.

Case incidence of Cerebro-Spinal Fever per 10,000 *of population.*

England and Wales	1914	0·1
	1915	0·7
	1916	0·7
London	1914	0·2
	1915	1·4
	1916	1·0
In Glasgow in 1907 during a local epidemic the corresponding rate was		12·4
In Belfast in the same year the corresponding rate was		1·7
In New York in 1905		6·3
In Melbourne in 1916		5·7

The *distribution* of cerebro-spinal fever throughout England and Wales has been very irregular. In 1915 the civilian mortality in the south was 80 per million as against 35 in the Midlands, 25 in Wales, and 12 only in the North. Dr. Stevenson in the 78th Annual Report of the Registrar-General (1915) also gives the following death rates per million of civil population for the year 1915—London 74, County Boroughs 32, Urban Districts 36, Rural Districts 34. He notes that the mortality amongst the troops occurred earlier in the year than that in the civilian population, and that, so far as can be judged from notification returns, the case-mortality was about 53 per cent. both in the civilian and the military population.

Age and sex.—A majority of the cases notified are of the male sex. Nearly one-half of the total cases in the civil population occur at ages under 5, and from three-fourths to four-fifths of the total cases occur at ages under 15. (See table on p. 75 of Dr. Reece's report, New Series, No. 110.) This is true for recent epidemics, and appears to have held good for earlier epidemics. Thus of 1,179 deaths from cerebro-spinal fever in Massachusetts in 1887-95, 76 per cent. were at ages under 15.

Seasonal distribution.—The seasonal incidence of cerebro-spinal fever is well shown in the chart on page iii. About three-fifths of the total cases occur in March, April and May, one-fifth in December, January and February, one-seventh in the summer months, June, July and August, and the rest in the autumn months.

Epidemics.—An account of the international epidemiology of cerebro-spinal fever was contributed by Dr. Bruce Low to the report, New Series, No. 110 (pages 115-182), and Dr. Reece in the same volume (pages 73-114) described the earlier part of the recent epidemic in this country. So far as the recorded outbreaks enable one to state, it would appear that among European countries France has suffered most, having during the 19th century had 62 epidemics. Of this number 43 were confined to troops. In Germany also many severe outbreaks have occurred. In Italy outbreaks appear to have been limited chiefly to the military population. The north-eastern portion of the United States has suffered seriously from cerebro-spinal fever; while in this country outbreaks have been few and on a relatively small scale.

Briefly it may be said that cerebro-spinal fever has prevailed over the world, and under varying conditions as to climate, topography, and sanitary, social and commercial circumstances.

Conditions under which epidemics arise.—But little is known as to these. In this respect there is some resemblance between influenza and cerebro-spinal fever. Both diseases occur at irregular intervals in widespread epidemics, embracing whole continents; while in the inter-epidemic periods sporadic cases or even small outbreaks occur, which do not appear to possess the power to spread and consequently die out. In influenza, however, insusceptibility to attack is unusual; in cerebro-spinal fever it is the rule, the difference possibly being bridged over by minor catarrhal or febrile attacks due to the meningococcus, in which meningeal invasion fails to occur.

The circumstances associated with excess of influenza and of respiratory affections, appear also to favour the prevalence of cerebro-spinal fever; although, as will be seen from the diagrams on pages vi. and vii. (figs. 2 and 3) the great epidemic of influenza in this country in 1890-92 was unassociated with, and was not followed by, the occurrence of epidemic cerebro-spinal fever. Since 1890 influenza has remained prevalent in this country with epidemic exacerbations in 1894, 1900, 1908, and 1915. It is likely that deaths from other catarrhal infections have been included to an unknown extent in these epidemics of "influenza." It is only in 1915 that any epidemic prevalence of cerebro-spinal fever coincided with, or followed, an epidemic of influenza.

The same plate shows the yearly incidence of deaths from bronchitis and pneumonia in England and Wales. As might be expected, epidemic peaks for these diseases correspond fairly well with those of influenza, though the correspondence is not exact in time, and is not quantitative.

It may be stated generally that cerebro-spinal fever is one of a group of catarrhal diseases, and that it commonly becomes excessively prevalent at the season of the year and under climatic or other conditions which favour excessive prevalence of influenza, bronchitis and pneumonia. Its response to these influences is, however, erratic; for under conditions which appear somewhat regularly to favour excess of bronchitis and pneumonia, and less regularly of influenza, cerebro-spinal fever may remain entirely quiescent.

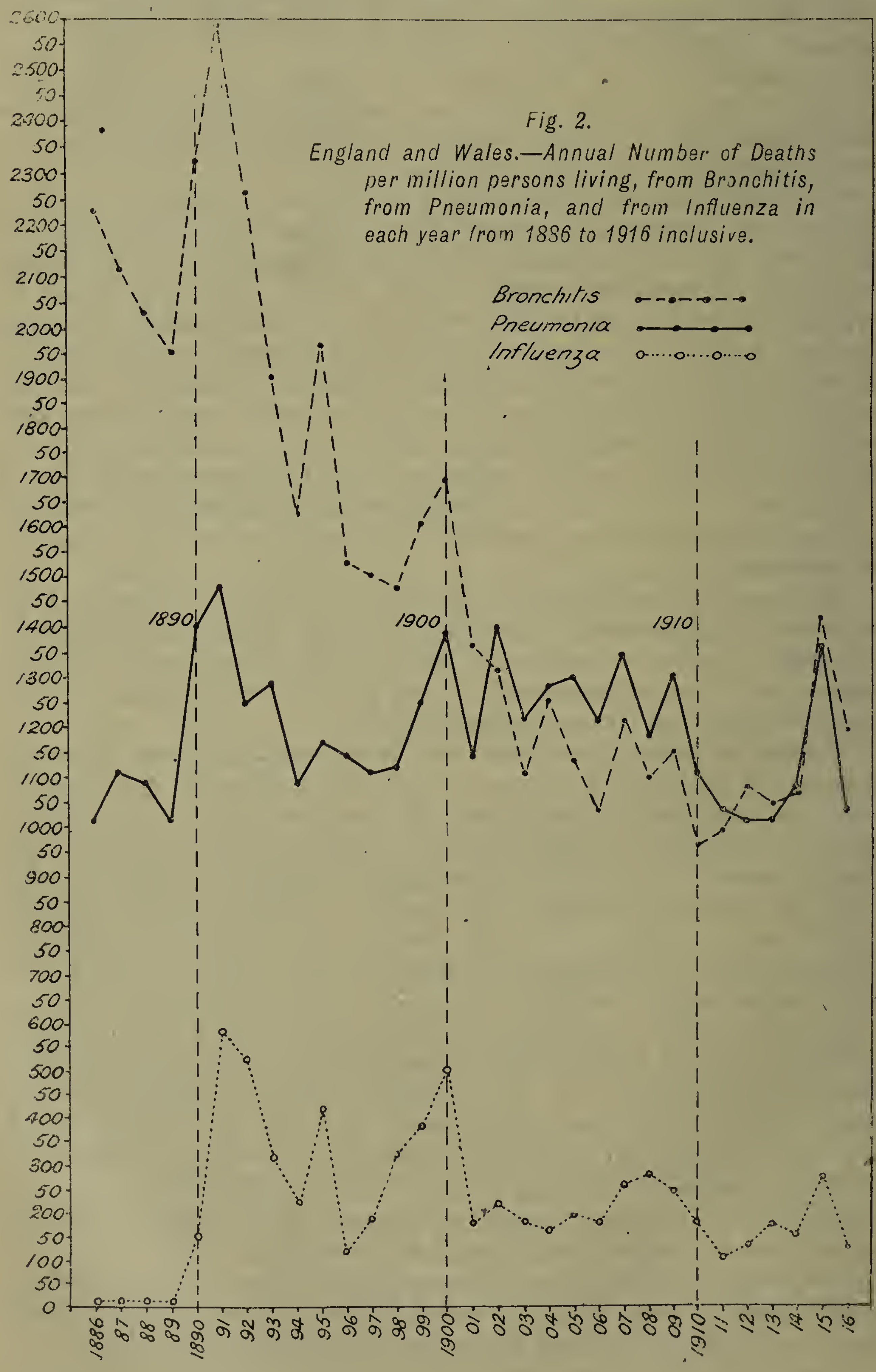
As in the case of influenza, the factors determining epidemics of cerebro-spinal fever remain obscure. It is to be noted that, whereas observations on a large scale have shown that major epidemics of diphtheria, scarlet fever and rheumatic fever occur as a rule during dry years or during a succession of dry years, no such association holds good for cerebro-spinal fever.

Infectivity.—The universal experience of outbreaks of cerebro-spinal fever enables certain facts to be stated.

(1) In the vast majority of instances only one case of cerebro-spinal fever occurs in an invaded household, or military hutment, and sometimes only one case in an invaded locality.

Arkwright states that among 30,000 soldiers 40 cases of cerebro-

spinal fever occurred, but no two cases arose in the same hut or tent. In the Glasgow outbreak Chalmers found multiple cases in 3·8 per cent. of 186 invaded households during 1906, and 7·5 per cent. of multiple cases in 413 invaded households during January to March, 1907. In the three years 1914-16, 369 cases of cerebro-spinal fever occurred in Glasgow. In only three instances were there multiple cases in the same house. The particulars given as to 2,343 cases of cerebro-spinal fever occurring in the civilian population of England and Wales



during 1915, show that in 150 instances multiple cases occurred in the invaded households.

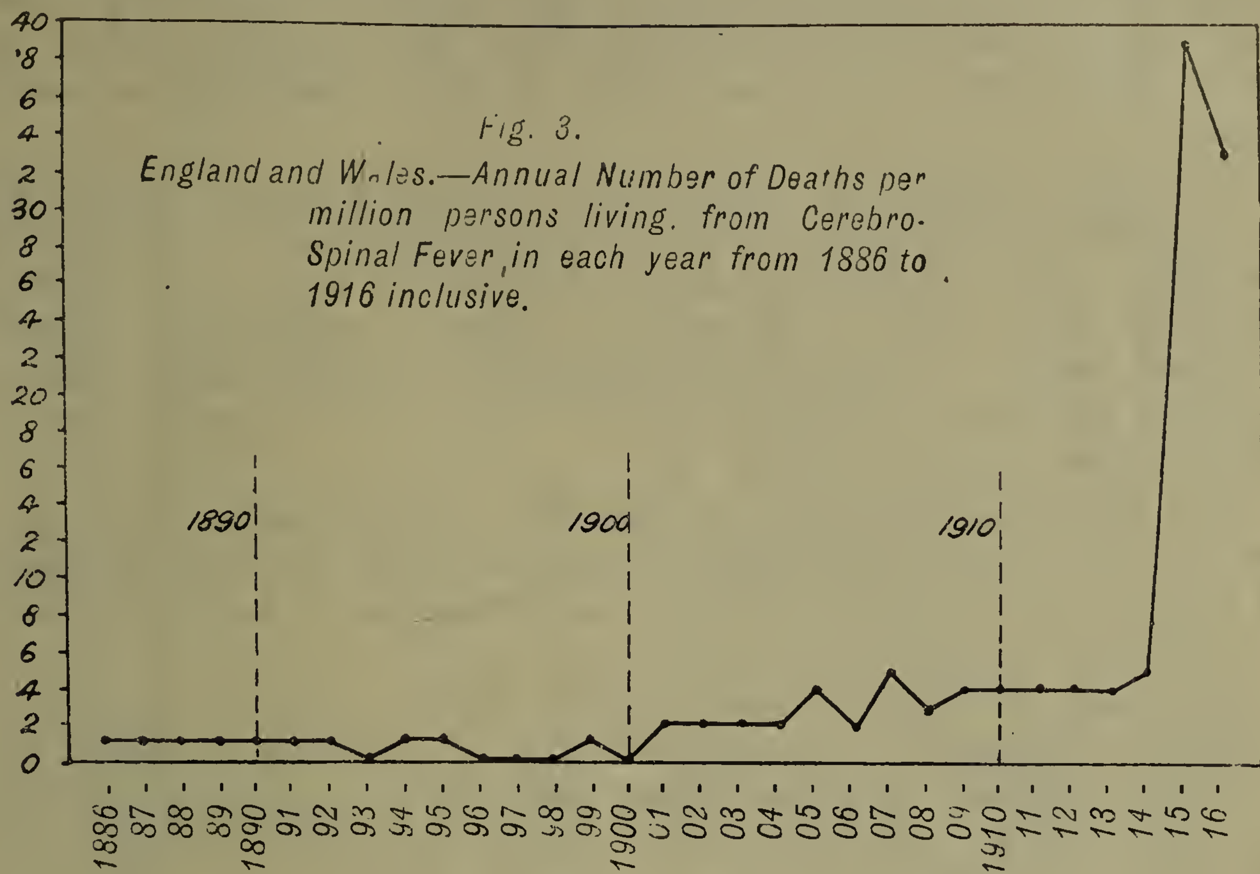


Fig. 3.
England and Wales.—Annual Number of Deaths per million persons living, from Cerebro-Spinal Fever, in each year from 1886 to 1916 inclusive.

(2) It would be erroneous, however, to assume that risk of infection is non-existent. Doctors and nurses on rare occasions are attacked. It is, of course, arguable that the incidence among attendants on the sick may not be greater than among average members of the community—a point difficult to test; but it would be unwise not to assume that increased risk accompanies close association with the sick.

(3) Even in carefully studied outbreaks it is exceptional for infection of a patient to be ascribable to any known case of cerebro-spinal fever. In other words, direct association with the sick is neither a necessary nor even a common factor in contracting cerebro-spinal fever.

(4) Apparently healthy contacts with persons who develop cerebro-spinal fever frequently harbour meningococci in their naso-pharynx.

(5) The same thing occurs among apparently healthy persons who have not been in contact with a cerebro-spinal fever patient, but who reside in communities in which such cases have occurred.

(6) There is evidence to the effect that meningococci are to be found in the naso-pharynx of persons living in areas in which there has been no outbreak of epidemic cerebro-spinal fever.

(7) *Method of spread.*—On the evidence it is reasonable to assume, as stated at the beginning of this memorandum, that cerebro-spinal fever is usually caused by spray infection, or by direct contact, as in kissing, or indirect contact, as by the use of eating or drinking utensils in common. Indirect infection by dust or fomites is very improbable.

(8) Infection may be spread by healthy "carriers," as well as by patients suffering from cerebro-spinal fever. Some of these "carriers" have, others have not, associated with a case of cerebro-spinal fever.

(9) In view of their larger number and their freer access to members of the general community, carriers of meningococci, who are not themselves suffering from cerebro-spinal fever, are more important in the causation of this disease than actual cases.

(10) Even during an epidemic of cerebro-spinal fever, the cases of this disease are scattered sporadically as in non-epidemic periods. The difference nearly always is one of number of sporadic cases, not of direct or indirect connection between clinical cases. It is only exceptionally, furthermore, that a definite grouping of clinical cases around, or progress from, a single focus can be traced.

The sporadic incidence of cases in an epidemic, e.g., in a town or in a military camp, is true not only in point of place; it is true also in point of time, the cases usually being scattered over several months.

The fact that the sporadic habit of the disease persists in epidemics indicates the impossibility of drawing a sharp distinction between epidemic cases and cases occurring in non-epidemic times. Evidently the former resemble the latter in important ætiological respects though differing in that, for some reason not as yet fully elucidated, they occur in greater numbers.

The sporadic cases of non-epidemic times, as has been pointed out, are to be correlated with the presence of an appreciable percentage of carriers. There are similar carriers in epidemic times, termed "non-contacts" to distinguish them from contacts with epidemic cases, and their significance requires careful consideration. The Board's investigators have shown that during the epidemic of 1915-17 the percentage of non-contact carriers has been notably high, though it is uncertain whether their figures show a marked increase above the normal rate, as no enquiry into non-contact carriers has been conducted with similar care prior to this epidemic. Their results are tabulated on the next page.

Relation of case-rate to carrier-rate.—It is clear from these results that in populous areas the non-contact carrier rate may be as high as 10 per cent., or may even exceed this figure. And, taking a much lower estimate (about 2 per cent.) which has been put forward by some writers before these data were available, even this computation implies a very extensive currency of the meningococcus, since the organism appears rarely to persist for more than a brief period in the same individual. It follows that the non-contact carrier rate alone would account for many times the number of cases of cerebro-spinal fever which have actually occurred in the present epidemic, even on the assumption that the number of carriers is many times greater than the number of cases. For example, suppose that in London during the year 1916 the non-contact carrier rate was only 2 per cent.* and that the meningococci of each carrier only circulated amongst 10 persons during the course of the year, and suppose also that the

* The inclusion of contact carriers might slightly increase this rate.

Examination of non-contacts for meningococci.

Names of observers.	Dates of examination.	Numbers of swabs examined.	Sources of material.	Percentages of persons yielding meningococci (culture tests alone).
Eastwood and Griffith ...	March—April, 1915 ...	100	Out-patients at St. Bartholomew's Hospital, E.C.	20
,, ,,	April—May, ,, ...	100	Do. do.	7
Scott	May, ,, ...	56	Children at rural school in Kent	2
Eastwood and Griffith ...	May—June, ,, ...	100	Out-patients at St. Bartholomew's Hospital, E.C.	6
,, ,,	June, ,, ...	100	Do. do.	7
,, ,,	June—July, ,, ...	80	Do. do.	11
Lewis	May—July, ,, ...	100	Persons in Birmingham (normal and hospital out-patients) ...	9
Scott	June—July, ,, ...	138	Out-patients at Lambeth Infirmary, S.E.	22
Nabarro	May—October, ,, ...	100	Children at Great Ormond Street Hospital, W.C.	7
Lewis	August—Nov., ,, ..	100	Persons in Birmingham (normal and hospital out-patients) ...	7
Eastwood and Griffith ...	January, 1916	100	Out-patients at St. Bartholomew's Hospital, E.C.	9
Lewis	March—May, ,,	100	Persons in Birmingham (mostly female hospital nurses)	3
Nabarro	January—June, ,,	106	Children at Great Ormond Street Hospital, W.C.	6
Eastwood and Griffith ...	April—June, ,,	100	Out-patients at St. Bartholomew's Hospital, E.C.	34
Ponder	June—July, ,,	200	Out-patients at Cambridge Hospital	15
,, ...	August, ,,	100	Patients at Norfolk and Norwich Hospital	27
,, ...	October, ,,	100	Healthy workpeople in Cambridge	37
Lewis	Nov., 1916—Feb., 1917 ...	101	Persons in Birmingham (mostly recruits and munition workers) ...	13

Summary—253 positives (13·5 per cent.) amongst 1,881 persons.

ratio of case-rate to carrier-rate should be 1:100; this would imply something like 8,500 cases of cerebro-spinal fever. The number actually notified was 428. The proportion of case- to carrier-rate, therefore, is evidently much below 1:100 in this instance. These considerations are in conformity with the view that case-rate is not deducible from carrier rate, and that the occurrence of an epidemic cannot be satisfactorily explained as due to an increase in the latter. The percentage incidence of non-contact carriers as shewn in the table on page ix. shows no correlation with the incidence in time of cases of cerebro-spinal fever as shewn in the chart facing page iii.

Comparison between cerebro-spinal and non-contact strains of meningococci isolated during the epidemic.

As the cerebro-spinal strains had given evidence of their virulence, but no such evidence was forthcoming in the case of the non-contact naso-pharyngeal strains, it was thought that comparative serological tests would determine whether the former differed as a class from the latter; such serological differences, if found, might then be correlated, respectively, with greater and feebler capacities for invading the tissues. As a result of this comparison, the Board's investigators have provided the following serological confirmation of the identity of their non-contact strains with strains of cerebro-spinal origin.

Serological confirmation.

1. *Strains collected by Eastwood and Griffith.*—Dr. Griffith has tested 86 of these, and has found that they "are not serologically separate and distinct from the cerebro-spinal strains, and moreover have not been found to exhibit among themselves such serological differences as would justify the separation of any number of them into a class or classes, identical with each other and distinct from meningococci of cerebro-spinal origin." He concludes that meningococci form a well-defined species, and that they can be identified in the naso-pharynx by careful application of cultural and fermentation tests, without resort to serological methods of diagnosis.

2. *Strains collected by Scott.*—Dr. Scott has tested 71 of his strains, and states that "the strains obtained from the majority of carriers afford proof of complete serological identity with known pathogenic strains. Inclusion of those persons who were found to be carrying strains not fully identified serologically did not raise the percentage of carriers to a significant extent." He concludes that "any strain possessing the admitted morphological and cultural characters of the meningococcus should be regarded as potentially pathogenic without considering its serological reactions."

3. *Strains collected by Ponder.*—Captain Ponder reports:—"Agglutination tests as a whole indicated that about 74 per cent. of strains collected on account of their resemblance to the meningococcus in culture, gave evidence of relationship to the meningococcus in virtue of their agglutination reactions with

anti-meningococcal sera. . . . . . With regard to those naso-pharyngeal strains which were not identified with cerebro-spinal strains by serological tests (agglutination and absorption), I consider that in view of the great variation in the serological reactions shown by different strains of undoubted meningococci, and even by different emulsions of the same strain, it is very difficult, if not impossible, to exclude any such microscopically and culturally typical organisms from the meningococcus group on the basis of serological tests."

4. *Strains collected by Lewis.*—Dr. Lewis states that his strains "include some which agglutinate with meningococcal sera, and which themselves produce sera which agglutinate meningococcal strains." He concludes that "serological tests do not exclude the naso-pharyngeal cocci of non-contacts from the community of meningococci, but that on the other hand the tendency of these tests is to show some affinity of grouping between these organisms and the grouping of known meningococci."

5. *Strains collected by Nabarro.*—Dr. Nabarro has not reported on serological tests.

It is clear from these results that the non-contact strains do not form a serological class distinct from the cerebro-spinal strains. If the percentages given in the table on p. ix. were modified by elimination of all non-contact strains not identified serologically with one or more cerebro-spinal strains, the reduction would be too small to affect the significance of the fact that in this epidemic there has been complete serological identity between a large number of non-contact strains and the strains responsible for the epidemic.

Carriers of meningococci in relation to epidemics of cerebro-spinal fever.—Healthy carriers of meningococci are mainly responsible for cases of the disease. Such persons are not uncommon in non-epidemic periods; and—though bacteriological evidence is not complete on the following point—the carrier rate may have increased, perhaps greatly increased, at the time when an epidemic first reveals itself. Search for and control over carriers is not, therefore, likely to be feasible, unless under conditions such as those of institutional or military life, in which all movements can be strictly regulated.

As regards the significance of a large carrier rate, there are two possible factors to consider. The carrier condition may be one means of acquiring partial immunity, which may conceivably be localised in the naso-pharynx and not necessarily demonstrable by serological tests. On the other hand, increase of the carrier rate means wider circulation of the meningococcus amongst the population and consequently greater opportunities of picking out susceptible persons. Apart from the danger to themselves, some such susceptible persons may be a danger to others; they may raise the virulence of their naso-pharyngeal meningococci to epidemic pitch, and, before falling victims to the disease, may transmit these more dangerous organisms to other persons. A relatively slight increase of virulence would

probably mean an increase in the number of persons susceptible to such exalted strains; this would harmonise with the fact that, in epidemic times, there is a small percentage of instances in which more than one case of the disease is attributable to the same focus of infection. There is a suggestive analogy with the pneumococcus. A small percentage of the total cases of pneumonia is not "sporadic" but directly "epidemic", in the sense that they are attributable to the spread of the disease from individual foci.

Imported and endemic meningococci.—Canadian troops suffered severely from cerebro-spinal fever while in camp in this country in the early months of 1915, and cases of this disease had occurred among them before their arrival here. (Dr. Reece's report, New Series, No. 110, p. 77.) It is not unlikely that a more virulent strain of meningococcus may have been introduced by these troops; and this hypothesis has received somewhat wide acceptance. Dr. Griffith, in his report, advances serological reasons in support of this view (page 102). Some military cases of cerebro-spinal fever had, however, occurred in this country before the arrival of these troops; and under similar circumstances of overcrowding, wet, cold weather, etc., British troops began about the same time as the Canadian troops to be affected with cerebro-spinal fever. It cannot be affirmed or denied that they were infected by imported meningococci.

Temporarily enhanced virulence of endemic meningococci.—An alternative hypothesis, not necessarily exclusive of the hypothesis of importation, is suggested by Dr. F. Griffith on the ground of his serological observations (page 105). In epidemic times strains make their appearance which possess greater intrinsic capacity for invading the tissues than the strains current in non-epidemic seasons. As epidemics are intermittent, this emergence of more virulent strains must be due to intermittent causes; and it is still necessary to assume the action of some unknown influence, telluric, climatic, or other, which becomes operative under conditions of which we remain ignorant.

Conclusion.—The Board's pathologists have shown that all meningococci must be regarded as capable of causing meningitis under favourable conditions, though these organisms usually occur as harmless saprophytes, and that careful cultural tests suffice for the identification of the meningococcus.* They have also shown that serological tests reveal differences between different strains. These differences in serological reactions may be regarded as having importance in directing the treatment of cerebro-spinal fever by sero-therapy. It will thus be of practical, as well as of scientific interest, to determine as far as possible the serological characteristics of the cerebro-spinal meningococci found in different outbreaks. But, under the conditions of civilian administration, there would be great practical

* Similarly the Special Advisory Committee which reported to the Medical Research Committee in 1916 say "we should regard a meningococcus-like organism which gave *all* the cultural reactions of the meningococcus as certainly capable of producing meningitis."

difficulties in undertaking serological identification of naso-pharyngeal strains, and it is doubtful whether practical advantage would accrue from attempting it. Even if any special significance were to be attached to those contacts yielding strains serologically identical with strains known to be responsible for cases of the epidemic disease, there remains the fact that a considerable percentage of the non-contact population harbour in their throats meningococci* which also are potentially pathogenic, but over whom no administrative control is practicable.

It is proposed to revise and reissue shortly the Memorandum on Cerebro-Spinal Fever modified in some particulars in the light of the experience of the past three years.

This experience emphasises the importance of general hygienic precautions in the prevention of meningococcal infection.

Inasmuch as during the prevalence of cerebro-spinal fever a considerable proportion of the general public harbour meningococci, it is desirable that certain precautions should become customary.

These precautions are similar to those needed to diminish the spread of any catarrhal infection, and include the careful use of handkerchiefs in sneezing and coughing, the avoidance of direct spray infection from person to person, and the occasional use of antiseptic gargles and sprays.

When a higher standard of conduct in regard to the prevention of catarrhal infections becomes the rule in social intercourse, a large amount of serious illness will be avoided in adults; and much of the total heavy mortality from diseases of respiratory origin in young children will also be prevented.

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* A large proportion of these strains has been shown to be serologically identical with strains isolated from cases of the epidemic disease.

ARTHUR NEWSHOLME.

Local Government Board,

August, 1917.

II.—Second Report on Bacteriological Aspects of the Meningococcus Carrier Problem. By Arthur Eastwood, M.D.

CONTENTS.

(4855.) Wt. 874—33676/286. 750. 10/17. J. T. & S., Ltd. G. 14. Sch. 17.

INTRODUCTION.

In my first report* I showed that in the throats of persons not known to have been in contact with cases of cerebro-spinal fever organisms were frequently found which were indistinguishable from meningococci isolated from the cerebro-spinal fluid of persons suffering from that disease.

During 1916 the investigators in the Board's Laboratory have continued to make further bacteriological inquiry into the characteristics of such naso-pharyngeal organisms, and into their relationship to strains obtained from the cerebro-spinal fluid in cases of meningococcal meningitis. In addition to Drs. F. Griffith and W. M. Scott, who have been occupied with this research throughout the year, Captain C. W. Ponder, R.A.M.C., has taken part in the investigation since June, 1916, when he was loaned to the Board by the War Office for this purpose.

Before discussing scientific details it will be useful to set out the main objects of the present work in general terms.

With the view of ascertaining whether further investigation would corroborate the previous year's findings, more naso-pharyngeal swabs from non-contacts have been examined, and this inquiry has been extended into localities distant from those previously investigated. The results have been confirmatory of the previous work, in that many additional non-contact strains have been found which are indistinguishable from meningococci of cerebro-spinal origin.

Whilst these facts point to a wide distribution of the meningococcus amongst the population of the areas investigated, it is necessary, before drawing general conclusions, to consider whether the tests applied for the identification of this organism have been sufficient, and whether some test might not be found which would serve to differentiate meningococci of cerebro-spinal origin from the majority, at least, of those which occur in the throats of non-contacts. With this object Drs. Griffith and Scott and Captain Ponder have paid special attention to serological reactions, as possibly affording a means of differentiation.

The problem would be simple if it were possible to adopt one meningococcal serum as the standard and to lay down the law that naso-pharyngeal strains which are agglutinated by this serum are meningococci, and that strains which are not agglutinated by it are not meningococci. But any such simple solution is quite out of the question. It is clear from the last reports by the Board's investigators that undoubted meningococci of cerebro-spinal origin differ among themselves in their serological reactions, and that no one serum is available which will agglutinate them all. This fact has been amply confirmed by other bacteriologists.

Can the difficulty be met by using a larger number of standard meningococcal sera, on the hypothesis that, if each variety of true meningococcus be represented serologically, an organism which agglutinated with at least one of the sera would be a

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* Reports to Local Government Board on Public Health and Medical Subjects. New Series. No. 110. 1916.

meningococcus, whilst failure to agglutinate with at least one serum would exclude an organism from this class?

This hypothesis raises important issues which must first be clearly defined, and then be examined in the light of laboratory data.

(1) How many standard sera would be required? If two or three would suffice, it would not be impracticable to test each unknown strain against each serum; but if a large, and perhaps indefinitely large, number of sera would be needed, the method would be impracticable for routine diagnosis.

(2) Would it be possible to establish identity of standards? One laboratory mght adopt a certain set of sera as being the most useful for differentiation, and another laboratory, with equal right of scientific authority, might adopt a different set, which might give different results. Then the decision as to what was or was not a meningococcus would be no more than the expression of a personal opinion, and would vary according to the views of the particular investigator.

(3) Would the results of simple agglutination tests necessarily be diagnostic? One knows that for certain organisms—*e.g.*, the typhoid bacillus and the cholera vibrio—the ordinary agglutination test is extremely useful, and, indeed, invaluable; and though the bacteriologist has to keep on the alert for possible fallacies, the need for caution does not detract from the fact that, with these organisms, the agglutination test is of very great practical utility. But agglutination with a coccus is much more irregular, and so many precautions have to be taken to avoid error that the question arises, certainly in the case of the meningococcus, whether the result of a simple agglutination test can be accepted as a final criterion for routine diagnosis.

(4) Is there any way of improving the agglutination test so as to overcome the difficulties met with in the meningococcus? The difficulties are twofold, and are similar to the difficulties encountered in serological tests with other organisms. Sometimes (*a*) a standard meningococcus serum may agglutinate organisms which are not meningococci—*e.g.*, it may agglutinate gonococci; and sometimes (*b*) an undoubted meningococcus may fail to agglutinate with any standard serum, just as a pneumococcus may fail to agglutinate with any standard pneumococcal serum, although it may be known to have produced lobar pneumonia. A suggested way out of the difficulty (*a*) is based on the principle that if a serum prepared from an organism A agglutinates not only A but also a different organism B, these two different capacities of the serum can be separated out by treating the serum with a culture of B and then removing the deposit; the clear liquid remaining will be found to have lost its power of agglutinating B but to have retained its power of agglutinating A. If the serum had been treated with a culture of A, instead of B, and then retested, its power of agglutinating A would have disappeared. This indicates a method of ascertaining whether an unknown organism which is agglutinated by serum A (a meningococcal serum) is identical with A (a meningcoccus) or is really some different organism (B). It also suggests (*b*) a

method of ascertaining whether a culture of an unknown organism which is not agglutinated by serum A is of the same type as culture A; if it is, the serum, after treatment with the culture in question, will have lost its power of agglutinating culture A; but if it is not, the capacity of the serum for agglutinating culture A will not be affected. These considerations naturally raise the question whether the proposed method of differentiation by "the absorption of agglutinin test" is reliable for the identification or differentiation of meningococci.

(5) The question last raised involves general principles of bacteriological classification, and the answer to it must involve consideration of these. The definite issue raised is whether the principle of differentiation by capacity for absorption of agglutinin is valid for the classification of organisms which, in other bacteriological respects, are essentially indistinguishable from each other. The practical importance of this problem may be illustrated by a well-known example. In certain intestinal disorders and in suspected food-poisoning there are two organisms, amongst others, which it is important to identify, viz., *B. paratyphosus* (B) and a widely-distributed organism known as *B. suipestifer*. These two are closely allied in their bacteriological reactions, and a good deal of research has been devoted to the question of their inter-relationship, both in England and in Germany. Opinion is still divided between two opposite schools, the one holding that the two organisms are clearly distinguishable by the absorption method, whilst the other maintains that both belong to the same group, and that they cannot be differentiated either by absorption or by any other bacteriological means. This illustration is particularly apposite to the question whether meningococci can be divided into (*a*) a pathogenic class and (*b*) a common but relatively harmless saprophytic class, because in the meningococcal problem the questions of scientific methods of differentiation and classification are identical with those raised in the controversy regarding *paratyphosus* and *suipestifer*.

(6) So far, I have only referred to the diagnosis of non-contact strains by means of sera prepared from cerebro-spinal meningococci. What further evidence of inter-relationship or differences would be obtained if sera were prepared from naso-pharyngeal strains and were fully investigated? Such information is obviously required, though the preparation of sera from unknown strains would not be practicable as a part of routine diagnosis.

(7) All these questions mean that serological diagnosis may be inaccurate unless it is based upon a correct appreciation of the limitations of the method employed.

It is therefore necessary to examine curernt assumptions about the principles of immunity, in so far as they affect the interpretation of certain serological reactions, and to enquire into the validity of their application to the differentiation of species.

(8) After due consideration of the above questions the final issue as to the diagnostic value of serological tests may be brought to a focus. The crucial question will be—a naso-pharyngeal strain is tested serologically and is found to give reactions which do not identify it as a meningococcus though it is identical with menin-

gococci morphologically, culturally, and in fermentation tests. Is such an organism to be regarded as possibly capable of producing cerebro-spinal fever? And if the answer is in the negative, the nature of the required serological identity must be defined.

THE DISTRIBUTION OF THE MENINGOCOCCUS AMONGST THE GENERAL POPULATION.

The Use of the Term "Non-Contact."

With reference to the work of the Board's investigators on the carrier problem it will be useful to clear up certain ambiguities attaching to the significance of the convenient terms "contact" and "non-contact."

There is, I believe, general agreement on the following matters:—

(1) Cerebro-spinal fever develops in persons who, prior to the onset of the disease, have "carried" the meningococcus in their naso-pharynges.

(2) The number of persons who develop the disease is very small in proportion to the number of carriers.

(3) The meningococcus is disseminated amongst the population by contact with carriers.

(4) When a person develops cerebro-spinal fever, some of the persons who have been in intimate contact with him will also, in all probability, be found to be carriers. Such carriers may be termed, collectively, Group I.

(5) It cannot be assumed that each member of Group I became a carrier owing to contact with the person who developed the disease; it is quite possible that the patient derived his infection from one of these healthy carriers.

(6) Persons not in contact with the patient may have been in contact with one or other of the persons A, B, C, etc., who constitute Group I, and may have become carriers in consequence, thus forming Groups A, B, C, etc.

(7) Similarly each individual in Groups A, B, C, etc. may be the focus of another group; and so the process may go on indefinitely.

(8) Carriers may retain the meningococcus in their throats for a long time, though not, as a rule, for more than two or three weeks.

It is thus evident that a case of cerebro-spinal fever can usually be regarded as associated, directly and indirectly, with an indefinitely large number of carriers, of whom (*a*) some are known to have been in contact with the patient; (*b*) a larger number can be found on enquiry to have been associated, directly or intermediately, with (*a*); and (*c*) a still larger number are intermediately connected with (*a*), but the connecting links cannot be traced. Then the rest of the population would comprise (*d*) all the persons, whether carriers or not, who have no connecting links, however remote or obscure, with (*a*).

To avoid ambiguity, therefore, the distinction between

"contacts" and "non-contacts" should be expanded into a distinction between (*a*) direct contacts (known), (*b*) indirect contacts (known), (*c*) unknown contacts (direct or indirect) and (*d*) persons who have not been contacts either directly or indirectly.

Turning now to the practical problem, what is wanted is to ascertain the distribution of the meningococcus in the general population, and for that purpose the population has to be "sampled." It is already known that a good many people who have been associated, directly or indirectly, with cerebro-spinal fever are carriers, but as it cannot be taken for granted that these persons are a representative sample of the general population, the "samples" must be taken from persons unconnected, so far as is known, with the disease. If it turns out that amongst these people, conveniently termed "non-contacts," carriers are few in number, the occurrence of such may possibly be explained on the hypothesis that they really belong to class (*c*), the "unknown contacts." But if, amongst such "non-contacts," carriers are found in considerable percentage, the hypothesis that they are really indirect but undiscovered cases of contact with the disease is of no assistance; it can neither be confirmed nor refuted, nor does it affect the main fact of practical importance that carriers are freely distributed amongst the normal population.

Interpretation of Negative Results.

The incidence of meningococci in the naso-pharynx is probably very irregular, varying in different localities and in different seasons, and therefore it is not surprising that there are marked differences in the percentages of "positives" found by different observers. And, apart from irregularities in the incidence of the cocci. it must also be generally recognised that the conditions under which the swabs are taken and investigated influence the results very materially. In taking the swab, avoidance of contamination with the common bacteria of the mouth is particularly important, because, as recently shown by Colebrook (*Lancet*, Nov. 20th, 1915), and Gordon (*British Med. Journ.*, June 17th, 1916), certain organisms commonly present in the mouth inhibit the growth of the meningococcus. In plating out the swabs, a liberal supply of medium is necessary in order to allow the development of discrete colonies, since the meningococcus, unlike hardier organisms such as the diphtheria bacillus, will either not grow at all or will not form recognisable colonies if it is surrounded and overrun by a confluent growth of other organisms. In preparing the medium for primary culture, enrichment with some adjuvant such as serum or ascitic fluid is necessary to promote the growth of naso-pharyngeal meningococci. The necessity for this has always been recognised by most bacteriologists, and recent investigations have served to emphasise its importance.* And, above all, plenty of time and care are necessary at every stage in the process, from the

* It must not be assumed that a medium which gives a good primary culture of cerebro-spinal meningococci is necessarily good for naso-pharyngeal meningococci; the cerebro-spinal fluid transferred to the plate along with the former organisms is itself an adjuvant to growth.

taking of the swab to the searching of the plate and the examination of suspicious colonies.

The above considerations must be taken into account when interpreting negative results, as these would lose their significance if they were not obtained under conditions specially favourable to the discovery of any meningococci possibly present. And, it may be necessary to point out, cases in which the cultures are overgrown should be separately recorded as such, and should be eliminated from the figures on which the percentage of positives is based.

NON-CONTACT CARRIERS AT ST. BARTHOLOMEW'S HOSPITAL.

In continuation of the work recorded in my previous report (pp. 38–39), Mr. C. E. West, F.R.C.S., Aural Surgeon to St. Bartholomew's Hospital, took naso-pharyngeal swabs from two further series of out-patients, and sent the material to the Board's Laboratory for bacteriological examination. As before, the patients were taken as general examples of hospital out-patients or convalescents, and had not, so far as could be ascertained, been in contact with any cases of cerebro-spinal fever. The same technique of investigation was observed as in the previous year's work. The results were as follows:—

I.—Cultural Tests of 100 *Naso-pharyngeal Swabs taken Jan.* 10*th*—24*th*, 1916.

Age period.	Males.		Females.		Totals (Male and Female).	
	Positive.	Negative.	Positive.	Negative.	Positive.	Negative.
0–5 years ...	0	6	0	5	0	11
5–10 ,, ...	1	10	0	8	1	18
10–20 ,, ...	0	14	1	17	1	31
20–40 ,, ...	2	10	1	10	3	20
Over 40 ,, ...	1	6	3	5	4	11
	4	46	5	45	9	91

In two of the nine positives, the original plates yielded pure cultures of meningococci; in four, the colonies of meningococci were numerous or moderately numerous; and in the remaining three the colonies were scanty.

II.—Cultural Tests of 100 *Naso-pharyngeal Swabs taken April* 6*th–June* 5*th*, 1916.

Age period.	Males.		Females.		Totals (Male and Female).	
	Positive.	Negative.	Positive.	Negative.	Positive.	Negative.
0–5 years ...	0	2	0	1	0	3
5–10 ,, ...	0	5	2	3	2	8
10–20 ,, ...	8	12	3	10	11	22
20–40 ,, ...	8	7	5	8	13	15
Over 40 ,, ...	6	8	2	10	8	18
	22	34	12	32	34	66

In one of the thirty-four positives, the original plates yielded a pure culture of meningococci; in twenty-five, the colonies of meningococci were numerous or moderately numerous; and in the remaining eight the colonies were scanty.

Two swabs, not included among the above, are interesting. One was taken on May 4th from a female patient, aged 53, suffering from Eustachian catarrh, and yielded numerous colonies of meningococci; on January 13th a swab from the same person had given a practically pure culture of meningococci. On May 4th a swab taken from a female patient, aged 52, suffering from pharyngitis, gave moderately numerous colonies of meningococci; a previous swab, taken on January 20th, had been found positive, with numerous colonies of meningococci.

On setting out the whole of the St. Bartholomew's Hospital results in successive batches of 100, the data are:—

Period.	Number of Positives.
March 29th—April 19th, 1915	20
April 19th—May 6th, 1915	7
May 6th—June 7th, 1915	6
June 24th—June 24th, 1915	7
*June 24th—July 22nd, 1915	†11
January 10th—January 24th, 1916	9
April 6th—June 5th, 1916	34

* *Only* 80 *cases examined.* † *Percentage.*

Carriers in Kent, Cambridge, and Norwich.

Dr. Scott has examined both contacts and non-contacts in East Kent, and has reported his results on pp. 153-7; and Captain Ponder has investigated the non-contact populations of Cambridge and Norwich (pp. 159-191).

It will be seen from Dr. Scott's report that a high percentage of persons carrying undoubted meningococci was found amongst non-contacts as well as amongst contacts; and Captain Ponder has shown that similar organisms were found in high percentage amongst non-contacts, including healthy workpeople, at Cambridge and Norwich. These results are in conformity with the figures obtained for London.

VALUE OF SIMPLE AGGLUTINATION TESTS AS AN AID TO DIAGNOSIS.

Is there a Pseudo-Meningococcus?

As I showed in my last report, many investigators have used the prefix "pseudo" without adequate justification. Apparently they took it for granted that genuine meningococci would not be found in the throats of non-contacts, and some of them failed to appreciate the difficulties of serological diagnosis which arise from the fact that strains of undoubted meningococci are not necessarily agglutinated by the particular serum employed. Hence a non-contact strain, though indistinguishable culturally from the meningococcus, was branded with some such prefix as

"pseudo" for the insufficient reason that it did not tally with certain standard strains in serological reactions. But since then it has been recognised that different strains behave differently towards different sera and exhibit a tendency to serological grouping. This is an important advance towards accurate identification and classification, and I note that, in view of this fact, the Medical Research Committee's Report* expresses the hope (p. 19) "that the terms 'para-' and 'pseudo-meningococcus' will in time be dropped."

But, whilst condemning arbitrary usage of the designation "pseudo," the above considerations are not enough to dismiss the important practical question:—Does the naso-pharynx harbour organisms which, though "meningococcus-like" and perhaps botanically related to meningococci, are incapable of producing meningitis?

In raising this question the position of organisms resembling the cholera vibrio may be considered as analogous. The search for the meningococcus in the human naso-pharynx may be compared to the search for the organism of cholera in an Indian water-tank, wherein there are frequently to be found vibrios which are "cholera-like" but are not true cholera. Greig, for example, has investigated a large number of such cholera-like vibrios and has found† that they resembled true cholera culturally, but were not agglutinated by a high titre cholera serum, and did not produce agglutinins for the standard cholera vibrio. The last test he regards as important, because, as he has explained in a previous article,‡ the true cholera vibrio may lose its agglutinability but does not lose its agglutinogenic capacity even if exposed to the action of water for a long period.

Reverting to the meningococcus, the parallel question will be:—

Are the organisms commonly found in the non-contact naso-pharynx distinguishable from cerebro-spinal meningococci in that they do not agglutinate well with any sera prepared by the latter and that they are incapable of producing sera which will agglutinate the latter?

On reference to the work of the Board's investigators it is clear that the great majority of non-contact meningococci do not answer to this description.

Dr. Griffith has compared the agglutinability of 66 cerebro-spinal strains and 86 non-contact naso-pharyngeal strains with six sera prepared with spinal strains and has found (p. 59) that 94 per cent. of the former and 72 per cent. of the latter were agglutinated up to 400 or over with one or more of these sera. On preparing monovalent sera with six of his naso-pharyngeal strains, he found (p. 64) that these latter sera showed:—"(*a*) good agglutination with cerebro-spinal meningococci, though usually short of full titre; (*b*) more uniform influence on

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* Report of the Special Advisory Committee upon Bacteriological Studies of Cerebro-Spinal Fever during the Epidemic of 1915.

† The Serological Investigation and Classification of Cholera-like Vibrios isolated from water in Calcutta. Indian Journ. of Med. Research, April, 1916.

‡ Published in the same Journal in Jan., 1916.

Group I strains; (*c*) agglutination of some of the Group II strains to half full titre." Supplementing these data with observations on a batch of more recently isolated cerebro-spinal strains, he has found (p. 110) that 19 out of 23 of these were agglutinated up to 400 or over by the serum prepared from his naso-pharyngeal strain NP 44 (titre 1:800).

Dr. Scott examined 71 naso-pharyngeal strains. Of these (p. 144), 44 agglutinated with his Group II sera (30 up to full titre, 9 to 1,000; and 5 to 500; one of the last 5 also went up to 500 with a Group I serum). Of the remaining 27, 14 agglutinated with Group I sera (2 up to 1,500, 2 up to 1,000, and 10 up to 500). As regards agglutinogenic capacity, 8 of these 14 naso-pharyngeal strains produced sera agglutinating certain cerebro-spinal members of Group I. Agglutinogenic capacity of naso-pharyngeal strains resembling cerebro-spinal members of Group II was not investigated.

Captain Ponder, who did not find that his cerebro-spinal strains were clearly separable into two main groups, tested the agglutinability of 94 non-contact naso-pharyngeal strains with sera prepared from cerebro-spinal strains, and found that 74 per cent. of these non-contact strains "gave evidence of relationship to the meningococcus in virtue of their agglutination reactions" (p. 190). He tested the agglutinogenic capacities of two of his naso-pharyngeal strains, Nos. 108 and 235, towards 16 spinal strains; 13 of these were agglutinated to 400 or over with the serum prepared from the former (titre about 1:400), and 9 of these 13 were also agglutinated to 400 or over by NP 235 serum (titre about 1:800).

Comparison Between the Non-Contact Meningococcus and the Pneumococcus "carried" by Normal Individuals.

Whilst recognising that there is no evidence of a valid analogy between water vibrios which are merely "cholera-like" and prevalent strains of non-contact meningococci, it might be urged that a better analogy is provided by recent serological work on the pneumococcus, the outcome of which is to suggest that the pneumococci commonly met with in the mouths of normal individuals, though genuine pneumococci and not merely "pneumococcus-like," are distinguishable from the majority of pneumococci which have been responsible for lobar pneumonia or other acute infection. As this is an important suggestion, which was raised a year ago in the Medical Research Committee's Report, it calls for consideration in the light of laboratory data.

In 1910, Neufeld and Haendel* called attention to the occurrence of pneumococci which did not agglutinate with standard sera, and expressed the opinion that extensive enquiry ought to be made into the prevalence of special types of pneumococci and into the occurrence and distribution of atypical strains.

Recognising the importance of the problem raised by Neufeld and his associates, Dochez and Gillespie (1913)† attempted to

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* Arb. aus d. Kais. Gesund., vol. 34, p. 293.

† Journ. of American Med. Ass., vol. 61, p. 727.

form a biological classification of pneumococci by means of immunity reactions. They investigated the pneumococci derived from 74 cases of typical lobar pneumonia and grouped them as follows:—

Group.	No. of Cases.	Percentages.
I.	35	47
II.	13	18
III. (*mucosus*).	10	13
IV. (heterogeneous)	16	22

As the Group III organism, the *Pneumococcus mucosus*, is distinguishable culturally from the pneumococci in the other groups, it does not concern the meningococcus problem. Omitting this group, there are left 64 cases, of which 35 (55 per cent.) fall into Group I, 13 (20 per cent.) into Group II, and 16 (25 per cent.) into Group IV. Groups I, II and IV were indistinguishable morphologically and culturally, but serological tests gave the following results. A Group I serum protected white mice against all Group I strains, but not against any strains of II or IV, and this serum also agglutinated all Group I strains, but no strains of II or IV. Similarly, *mutatis mutandis*, with Group II. Group IV is not a group in the same sense as the other two. It is the residue, and comprises organisms which all differ serologically from each other as well as from those in I and II. "This group comprises a number of distinct varieties of pneumococcus which cannot be related to one another by immunologic reactions. Culturally they are true pneumococci, and manifest all the common characters of pneumococcus." The authors go on to suggest that the other groups comprise the "fixed races," which "are more highly parasitic and are never very far removed from a condition of pure parasitism, whereas the heterogeneous strains may be representatives of the types of pneumococcus found in the normal mouth, and consequently more likely to have undergone environmental changes."

In continuation of the above work, Dochez and Avery (1914 and 1915)* examined the pneumococci from 71 additional cases of lobar pneumonia and classed them as follows:—

Group.	No. of cases.	Percentages.
I.	21	30
II.	28	39
III. (*mucosus*)	6	8
IV. (heterogeneous)	16	23

Omitting Group III and combining the remaining data with those previously recorded, out of 129 cases of lobar pneumonia,

* Journ. Exper. Med., vol. 21, p. 114 and vol. 22, p. 105.

there were 56 (43 per cent.) in Group I, 41 (32 per cent.) in Group II, and 32 (25 per cent.) in Group IV. The authors noted that the case mortality was lower in Group IV than in any of the other groups.

They also studied the pneumococci in convalescents from pneumonia, in healthy contacts, and in the sputum of non-contacts. In convalescents they found that generally the "fixed types," I–III, disappeared, and were replaced by IV, though sometimes a convalescent was a carrier of a "fixed type" for a long time. In healthy contacts the "fixed types" were often found. About 60 per cent. of the mouths of normal persons (not contacts) yielded pneumococci, but these organisms all belonged to Group IV.

With reference to the pneumococci in each of their 4 groups the authors say that "up to the present time we have observed no tendency of these organisms to lose their specific characters, nor have we observed a change of one type into another."

Cole (1915)* gives some further information as to the relative virulence of the 4 groups in cases of pneumonia, viz.:

Group.	Cases.	Deaths.	Mortality Percentage.
I.	28	7	25
II.	25	9	36
III.	17	8	47
IV.	33	2	6
	103	26	25

He also quotes the corresponding mortality statistics from the Pennsylvania Hospital, which show 29 per cent. for Group I, 27 for Group II, 67 for Group III, and 11 for Group IV.

Stillman (1916)† summarises for the four years 1912-13 to 1915–16 the types of pneumococci isolated from cases of lobar pneumonia admitted to the hospital of the Rockefeller Institute:—

Type.	Number of cases.	Percentage.
I.	105	33·54
II.	99	31·62
III.	35	11·18
IV.	74	23·64

The above data raise a clear issue. Do non-contact meningococci resemble the American Group IV pneumococci?

As regards pathogenicity, the Group IV pneumococcus is said to be responsible for about 25 per cent. of the cases of lobar pneumonia, though these cases have a relatively low death-rate. If the non-contact meningococcus bears a similar relationship to meningitis, it is obviously very far from being a harmless saprophyte.

* New York Med. Journ., Jan. 2, 1915, p. 1.
† Journ. Exper. Med., vol. 24 p. 651.

Serologically, Group IV pneumococci differ markedly from each other and show no relationship to Groups I or II. The data quoted above as to the serological reactions of non-contact meningococci and their relations to meningococci of cerebrospinal origin show that it is impossible to make a serological subdivision of meningococci which would place the non-contact strains in an independent group, resembling the Group IV pneumococci as regards individual differences in agglutinability and agglutinogenic capacity, and differing from the other groups of pneumococci which are said to be found only in pneumococcal infections or in contacts therewith.

It would, however, be unsafe to draw the conclusion that there is no real parallel between the non-contact carrier of the pneumococcus and the non-contact meningococcus carrier. On the contrary, there appears to be an interesting, and probably a very important, parallelism between the two conditions; and the inference I would prefer to draw from the literature I have quoted is that the American theory needs independent re-investigation in this country and cannot, at present, be regarded as permanently established.* Perhaps the American investigators are already beginning to discover this.

In the recent article by Stillman, to which I have referred above, there is the significant statement that, though Types I and II are not found in the normal mouth except in the case of contacts, recent studies have shown that Type III is "fairly common in the mouth flora of healthy individuals and infections with organisms of this type may be autogenic in nature." Type III, he goes on to say, was found in 44 out of 398 normal persons (23·4 per cent.) whilst Type IV was found in 58·5 per cent. There was no serological difference between non-contact Type III and pneumonic Type III; and it was found that the former might persist in the normal mouth for a long time. Here one may remark that the wide distribution of Type III (the *pneumococcus* or *streptococcus mucosus*) in normal individuals is not a new discovery. It is mentioned, for example, by Lingelsheim (1912)† as a well-known fact that this organism is a not uncommon inhabitant of the upper respiratory tract.

Since Type III, the most virulent of the so-called "epidemic" types, turns out to be an organism which quite commonly lives the existence of a harmless saprophyte, it is difficult to understand why the same should not be true of Types I and II. Further research is needed on this point. Perhaps a fuller investigation of the miscellaneous collection known as "Type IV" will throw some light on the question. In the earlier days of meningococcus work, before the importance of serological differences was appreciated, a great many strains were found which did not respond

* F. S. Lister has found that in the pneumonia of South African miners there are at least four groups of pneumococci in addition to those recognised by the Americans. (The South African Institute for Medical Research. No. VIII. An Experimental Study of Prophylactic Inoculation against Pneumococcal Infection in the Rabbit and in Man. Published by the Institute, Oct. 1st, 1916.)

† Kolle u. Wassermann's Handbuch der path. Mikroorg., 2nd Edition, vol. iv., p. 498.

to the particular sera with which they were tested and, on this account, might have been relegated to a miscellaneous scrap-heap similar to the American Type IV; but, now that more suitable sera have been obtained, the atypical residue which fails to respond to one or other of these has been greatly diminished. Similarly it may be possible to find pneumococcal sera which will rearrange and possibly link together the pneumococcal groups now known as I, II and IV. And, in this connection, another matter for consideration will be the possibility that bacterial antigen may be modified in the human tissues.

DIAGNOSTIC VALUE OF ABSORPTION OF AGGLUTININ.

Comparison between Intestinal Bacteria and Meningococci.

Certain investigators have claimed that between the two organisms *B. suipestifer* and *B. paratyphosus* (B), which are indistinguishable culturally and often agglutinate well with the same serum, a clear distinction can be brought out by resorting to the test for absorption of agglutinin. Their observations naturally raise the question whether the same method might not serve to distinguish between "non-contact" meningococci and strains of cerebro-spinal origin. I propose therefore first to state the evidence in support of the view that *B. suipestifer* and *B. paratyphosus* (B) are distinguishable by absorption of agglutinin and then to call attention to the results of this test when applied to meningococci obtained from different sources.

B. suipestifer and B. paratyphosus (B).

Boycott (1906)* in the course of an enquiry into the bacteriology of paratyphoid fever and the diagnostic value of serological tests, discussed the method of differentiation by absorption of agglutinin. As subsequent writers include Boycott amongst the investigators who are able to distinguish *B. paratyphosus* (B) from *B. Aertryck* (generally agreed to be identical with *B. suipestifer*) by the absorption method, it will be useful to select from Boycott's article the records of his experiments which have a bearing on this point.

(1) The serum of a rabbit immunised with *B. Aertryck* gave a titre of 1 : 2000 for a strain of *Aertryck* and the same for a strain of *B. paratyphosus* (B). Absorption with *Aertryck* completely removed agglutinin for both strains; whereas absorption with *paratyphosus* (B) removed all agglutinin for itself but removed none of the agglutinin for *Aertryck*.

(2) The serum from a patient named "Barkley" was tested on two occasions. On the first, absorption with a strain of *paratyphosus* (B) removed all agglutinin both for this organism and for a strain of *Aertryck*, whilst absorption with *Aertryck* removed agglutinin for itself but not for *paratyphosus* (B). On the second occasion, when the titre of the Barkley serum was 1,000 for a

* Journ. of Hygiene, vol. VI, p. 33.

strain of *Aertryck* and over 5,000 for a strain of *paratyphosus* (B), a single absorption with *Aertryck* removed the agglutinin for itself but did not affect the agglutinin for *B. paratyphosus* (*B*); absorption with *B. paratyphosus* (B) removed the agglutinin both for itself and for *Aertryck*, but only after treatment three times; the first and second doses of absorbing culture failed to remove agglutinin for either organism.

(3) The serum from a patient named "Valérie" lost its agglutinin for both *Aertryck* and *paratyphosus* (B) when absorbed with the latter organism; but, when absorbed with the former, the agglutinin was retained for *paratyphosus* (B) and lost for *Aertryck*.

The standard strain of *B. paratyphosus* (B) which Boycott used was "*Schottmüller B*, original strain (1901)"; and his *Aertryck* was a strain isolated by Prof. van Ermengem from an outbreak of food poisoning.

Bainbridge (1909)* used the absorption of agglutinin test for differentiating between *B. paratyphosus* (B) and the two indistinguishable organisms, *B. Aertryck* and *B. suipestifer*. The dilution of the serum used for absorption varied from 1:10 to 1:50 but was usually 1:20 or 1:40. It was found that differentiation was most clearly brought out "by comparing the agglutination limits of the serum for these bacilli after one or more absorptions with a moderate amount of bacilli."

A *B. Aertryck* serum (titre 1:5,000 for the homologous organism and also for a strain of *B. paratyphosus* (B)), when absorbed with *B. Aertryck*, failed to agglutinate either organism in 1:200; when the serum was treated with *B. paratyphosus* (B), the first absorption reduced the paratyphoid agglutination limit to 200 and the limit for *Aertryck* to 4,000, a second absorption brought down the former limit to below 100 and the latter to 2,000, a third absorption produced no further change.

A *B. paratyphosus* (B) serum (titre 1:5,000 for the homologous strain; 1:1,000 for a strain of *B. Aertryck* and the same for a strain of *B. suipestifer*), when absorbed with *B. paratyphosus* (B) failed to agglutinate all three organisms above 200; when the serum was treated with *B. Aertryck*, the first absorption reduced the paratyphoid agglutination limit to 4,000 and the limits for *Aertryck* and *suipestifer* to below 200; a second absorption reduced the paratyphoid limit to 2,000 and the limits for the other two organisms to below 100; a third absorption brought the paratyphoid limit down to 1,000.

A *B. suipestifer* serum (titre 1:10,000 for the homologous strain and also for a strain of *B. paratyphosus* (B)), when absorbed with *B. suipestifer*, failed to agglutinate either organism above 100; when absorbed with *B. paratyphosus* (B), agglutinin for this strain fell below 100 but agglutinin for *suipestifer* was retained at 10,000.

In the above experiments apparently the same three strains were used for producing the sera, for absorption, and for determining the titres of the sera before and after absorption.

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* Journ. of Path. and Bact., vol. XIII, p. 443.

Bainbridge has tabulated a further series of absorption experiments in which he used five sera (two *Aertryck*, two *paratyphosus B.*, and one *suipestifer*), absorbed each of these with an *Aertryck*, a *paratyphosus* (B), and a *suipestifer* strain, and determined the titre before and after absorption with three strains bearing the same designations (? actually the same strains). The results were in accordance with those obtained in the former series of experiments. Apparently some of the strains used in the second series, for producing the sera, for absorption, and for agglutination before and after absorption, were the same as those used in the first series.

Two of Bainbridge's standard strains, one *B. paratyphosus* (B) and one *Aertryck*, were the same as those used by Boycott. His two standard *suipestifer* strains were "(*a*) The laboratory strain (Král); (*b*) A strain obtained from Professor Wassermann."

O'Brien (1910)* isolated from an epizootic in guinea-pigs an organism belonging to the food-poisoning group. When tested with an *Aertryck* serum, this organism agglutinated up to full titre (1:5,000), as, also, did a strain of *B. paratyphosus* (B); absorption with *B. paratyphosus* (B) removed all agglutinin for itself but left agglutinin up to 1:2,000 for both *Aertryck* and the guinea-pig organism. When tested with a *paratyphosus* (B) serum, the guinea-pig organism agglutinated up to full titre (1:2,000), as, also, did a strain of *Aertryck;* absorption with *Aertryck* removed all agglutinin for itself and also for the guinea-pig organism, but left agglutinin up to 1:500, for *paratyphosus* (B).

Bainbridge and Dudfield (1911)† described an outbreak of acute gastro-enteritis caused by *B. paratyphosus* (B). Simple agglutination tests failed to discriminate between this organism and *suipestifer*, but the application of the absorption method brought out a sharp distinction in favour of the former bacillus.

Bainbridge and O'Brien (1911)‡ investigated the value of the absorption method for grouping a certain number of strains which agglutinated well with both *paratyphosus* (*B*) and *suipestifer* sera.

The material they used consisted, in the first place, of certain standard strains, all of which were well authenticated. These strains were:—(*a*) Schottmüller's original strain of *B. paratyphosus* (B), which had previously been tested by Boycott in 1906 and by Bainbridge in 1909; (*b*) a *B. paratyphosus* (B) strain from McWeeney, apparently the one used by Bainbridge and Dudfield in 1911 in the investigation mentioned above; (*c*) a *suipestifer* strain designated "Laboratory (Král)," which had been used by Bainbridge in 1909 and by Bainbridge and Dudfield in 1911; (*d*) a *suipestifer* strain from Uhlenhuth; (*e*) a *suipestifer* strain from Wassermann which had been used by Bainbridge in 1909.

Secondly, 24 laboratory strains of the paratyphoid or food-poisoning group were collected from various sources and were compared with the five standard strains.

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* Journ. of Hygiene, vol. X, p. 231.
† Journ. of Hygiene, vol. XI, p. 24.
‡ Journ. of Hygiene, vol. X, p. 68.

Referring to the technique of absorption experiments, the authors stated that it was possible by the addition of very large amounts of a heterologous bacillus to remove some of the homologous agglutinin from a serum, but they had not succeeded in removing all the homologous agglutinin in that way. "The difference between the amount of heterologous bacilli which must be added to serum to absorb only the heterologous agglutinin, leaving the homologous agglutinin intact, and that necessary to absorb much of the homologous agglutinin, is so large that errors cannot occur if reasonable care is taken." For example, they used 2 c.c. of a 1 : 10 dilution of *suipestifer* serum (titre, 1 : 20,000 for the homologous strain, 1 : 5,000 for a strain of *B. paratyphosus* (B)); absorbed with two agar slopes of *paratyphosus* (B), its agglutination limit was reduced to below 100 for *paratyphosus* but remained at 20,000 for *suipestifer*, and the latter limit remained unaltered when absorption was made with eight agar slopes. The authors observed that it was preferable to measure the maximum titre of agglutination with the serum after absorption rather than merely to observe the agglutination at one or two dilutions.

The authors have recorded in full the essential details of their laboratory work; as the results were uniform, a brief summary will suffice. The absorption tests divided their five standard strains into (1) (*a*) and (*b*), which conformed to their *paratyphosus* standard, and (2) (*c*), (*d*), and (*e*), which conformed to their *suipestifer* standard. Absorption tests also divided their 24 additional strains into (1) those conforming to their *paratyphosus* standard and (2) those conforming to their *suipestifer* standard, with the following exceptions—one (No. 19) agglutinated with unabsorbed *suipestifer* serum up to 10,000, and the titre after absorption with *paratyphosus* fell to below 100, but the same organism gave 5,000 with unabsorbed *paratyphosus* serum and after absorption with *suipestifer* the titre fell to below 200; of two other strains, one (No. 16) was a poor agglutinator and the other (No. 20) was practically inagglutinable with the two standard sera.

Meningococci.

For the details of the work on this subject I must refer to the reports by Dr. Griffith, Dr. Scott, and Captain Ponder.

Dr. Griffith (p. 57) has found that 62 of his 86 naso-pharyngeal strains agglutinate up to 400 or higher with one or more of his Group II sera prepared from spinal strains. He has tested the absorptive capacity of 33 out of these 62 strains, and has found that they all exhaust the homologous agglutinin from one or more of his spinal sera. This result, he considers, is sufficient to justify the conclusion that the remainder of these 62 strains would be found to absorb the homologous agglutinin from some Group II spinal serum. Of his remaining 24 strains, some, as he has shown in detail on pp. 85-8, are related in absorptive capacity to Group I strains of spinal origin.

Dr. Scott has found (p. 158) that 58 of his 71 naso-pharyngeal strains afford proof of complete serological identity (including identification by the absorption test) with known pathogenic strains.

Captain Ponder (p. 190) has not tested all his strains by the absorption method, but he has taken the cultures from his last series of 100 swabs, all obtained from healthy workpeople, and has submitted to the absorption test all those which were like meningococci in simple agglutination. He only employed one serum for this purpose. He found that nine of his strains absorbed agglutinin as well as the homologous coccus, and four others absorbed it partially. On applying the absorption test to another batch of strains he obtained similar results.

Validity of Differentiation by Absorption of Agglutinin.

The results of the work on the meningococcus suffice to show that absorption of agglutinin tests do not separate "non-contact" from cerebro-spinal meningococci in the way in which such tests divided the strains of *B. paratyphosus* (B) and *B. suipestifer* which were investigated by Bainbridge and O'Brien. This lack of correspondence raises several problems which require consideration, the first question being whether the work of Bainbridge and O'Brien justifies a general statement that organisms giving the cultural reactions common to the large group of which *B. paratyphosus* (B) and *B. suipestifer* are members can be differentiated by absorption of agglutinin. This statement has been disputed by certain German pathologists, on grounds which are given in the following summary.

Objections.

Uhlenhuth, Hübener, Xylander, and Bohtz (1909)* maintained that *B. paratyphosus* (B) and the hogcholera group of organisms could not be classified into separate groups either culturally or by serological tests. In this connection they discussed the contention that, though indistinguishable culturally and by simple agglutination tests, *paratyphosus* (B) and *suipestifer* were clearly separable by the adoption of Castellani's principle of differentiation by the absorption of agglutinin. This, they found, was not the case. They admitted that clear differences might be apparent if reliance were placed on a single strain as representative of each alleged group of organisms; but, when a large number of strains were used, the results of the absorption tests were so irregular that a demarcation into distinct groups became impossible. This irregularity they attributed to individual differences in the "receptor apparatus" of different strains. They based their conclusions on the results of absorption tests with a very large number of different strains and, in the present article, have taken one series of experiments as an example and tabulated their results. The table is too long to reproduce here, but it will suffice to quote some of the essential details of the experiments which it records.

Their method of conducting the tests was as follows: A rabbit serum (titre 1 : 5,000) was prepared from a human *paratyphosus* (B) strain named "Hellwig," and was diluted to 1 in 500. To 100 c.c. of this dilution was added, in the case of each

* Arb. a.d. Kaiserlich. Gesundheitsamte, vol. XXX, p. 292.

strain used for absorption, the 24 hours' growth obtained on 20 agar tubes. The mixture was incubated at 37° C. for two hours, and then centrifuged until completely clear fluid was obtained. For testing the absorbed serum as to its remaining agglutinating power (dilution 1:500), 1 loopful of 24 hours' culture was used to 1 c.c. of fluid; the mixture was incubated at 37° C. for one hour and then kept at room temperature for 24 hours. The same procedure was adopted in each test.

When the homologous strain, "Hellwig," was used for absorption, it removed the agglutinin for itself and for the 19 other human *paratyphosus* (B) strains which were tested.

But when other strains were used for absorption of this serum uniformity of results was no longer obtained.

Absorption with "Eb.," one of the above 20 human paratyphoid strains, removed agglutinin for itself but not for "Hellwig," and with the remaining 18 strains the results were irregular, agglutinin being removed for 8 but retained for 8 others, whilst with the last two the result of the test was doubtful.

Absorption with "England," another of the above 20 strains, removed agglutinin for itself, for "Eb.," for "Hellwig," and for 12 other of these strains, but failed to remove agglutinin from the remaining five, including one which gave the opposite result when the serum was absorbed with "Eb."

The "Hellwig" paratyphoid serum was then absorbed with certain strains of *suipestifer* obtained from pigs, using the same quantities of culture and the same technique in every respect as in the former experiments. The first *suipestifer* strain removed agglutinin for 18 out of 27 *suipestifer* strains, all isolated from pigs; but it also removed the agglutinin for "Hellwig" and for 12 other of the 20 human *paratyphosus* (B) strains. It failed to remove the agglutinin for "Eb.," for "England," and for 4 other strains. With the one remaining strain the result was doubtful.

A second *suipestifer* strain, from a normal pig, when used for absorption of the same paratyphoid serum, removed the agglutinin for 21 out of the 27 *suipestifer* strains; but it also removed the agglutinin for "Hellwig" and for 11 other of the 20 human *paratyphosus* (B) strains. It failed to remove the agglutinin for the remaining 8, including "Eb." and "England."

Similar irregularities in results were obtained when the serum was absorbed with other strains, e.g., a strain obtained from a case of food poisoning and one isolated from a sausage. These need not be quoted in detail, as the above data suffice to support the authors' statement that the method was found to be unreliable for diagnostic purposes. Of the five absorbing strains about which I have given details, only one gave unequivocal results; and that was the one used to produce the immune serum. The other two paratyphoid (B) strains used for absorption failed to absorb agglutinin for several paratyphoid (B) strains; and the two *suipestifer* strains used for

absorption, which, according to the absorption theory, should have left the paratyphoid agglutinin untouched, removed this agglutinin for more than half of the paratyphoid strains.

Are the Objections Valid?

The importance of the laboratory data, quoted above, which were recorded by Uhlenhuth and his co-workers in 1909, lies in the fact that, under identical conditions of experiment, the individuality of different strains comes out very strongly and makes its appearance in such irregular fashion that no basis is provided for a subdivision of these strains into distinct groups.

But, in the absence of fuller particulars, these results cannot be regarded as a conclusive proof that differentiation of these organisms by the adoption of Castellani's principle is impossible. No information is given as to the highest dilution in which agglutination was obtained after absorption, and there is no evidence that the quantity of culture used for absorption was the amount most favourable for enabling a group distinction to make its appearance.

For example, the paratyphoid serum (titre, 1:5,000) was absorbed with the paratyphoid strain "Eb." and it was found that the absorbed serum still agglutinated 8 paratyphoid strains at 1:500. But this is a very incomplete statement of the relationship of "Eb." towards these 8 strains. Presumably, these 8 strains agglutinated with the unabsorbed serum as well, or nearly as well, as the homologous strain. Did absorption with "Eb." leave their agglutination limit unaffected or only slightly affected, or did it bring that limit down somewhere to the neighbourhood of 500? As no answer to these questions is given, it is impossible to exclude the latter alternative. Furthermore, since no evidence is given to the contrary, one cannot exclude the possibility that a much smaller quantity of "Eb." culture would have been as effective, or nearly as effective, in bringing about a marked reduction of agglutinin for all the 20 paratyphoid strains.

Again, when a *suipestifer* strain was used for absorption, similar questions arise concerning its failure to remove agglutinin (at 1:500) for 9 out of 27 *suipestifer* strains. Possibly it effected a marked reduction of agglutinin for these 9 strains; and possibly a much smaller quantity of absorbing culture would have produced very similar results on all 27 strains.

Moreover, in the absorptions with *suipestifer* strains, the objection has not been met that the use of much smaller quantities of absorbing culture might have produced relatively little loss of agglutinin for paratyphoid strains but, at the same time, well marked loss for *suipestifer* strains.

It will be noted also that the serum used for absorption was very dilute (1:500), and therefore more readily affected than more concentrated sera.

In considering the work of Bainbridge and O'Brien it must at once be recognised that they have investigated a considerable number of strains and, by means of the absorption method, have succeeded in almost every instance in allocating each to one of

two groups, according as it conforms (*a*) to their *paratyphosus* standard or (*b*) to their *suipestifer* standard.

At first sight the fact that a considerable number of strains was used seems to dispose of Uhlenhuth's objection that division into groups is only possible when attention is confined to single strains as representative of each alleged group. The strains used for testing against the standard organisms were isolated from human or animal material sent to several different laboratories, and were therefore derived from several different and independent human or animal sources; and in most cases, presumably, it had been established in the laboratories providing these strains that they were typical representatives of the paratyphoid (B) and food-poisoning group of organisms, and were therefore suitable for submission to the absorption test. But here an important laboratory point arises. As a matter of routine diagnosis the strains must have been identified by testing their agglutinability with standard sera, and probably these standards were established either by the original strains regarded as representative of this group of organisms (*Schottmüller* (B) and Van Ermengem's *B. Aertryck*) or by strains proved to be identical with these. Many investigators have found that a "typical strain," i.e., one which conforms to their standards, can be differentiated by simple agglutination alone, since, when tested with good sera, its agglutination limit is much higher for *paratyphosus* serum than for *suipestifer* serum or *vice versâ*. It therefore seems fair to raise the question whether the majority of the strains sent to Bainbridge and O'Brien had already been selected as "typical," in the sense defined above, or whether they were random samples and truly representative of the range of variation of *B. paratyphosus* (B) and of *B. suipestifer* which may occur in nature. Bainbridge and O'Brien give no information on this point. They have, however, found that, when their 24 strains were tested with sera prepared by injection of living cultures, before resorting to absorption "some indication was revealed of the existence of two types of bacilli." Referring to their tabulated record of these experiments, it is seen that two of their 24 strains may be omitted as being poor agglutinators with both the *suipestifer* and the *paratyphosus* serum, and that each of the remaining 22 showed a clear difference between its agglutination limit with the one serum and its limit with the other. This difference was never less than 2 : 1 (e.g., 20,000 as against 10,000 or 10,000 as against 5,000) and occasionally it was much greater. These results are strong indication of initial conformity to standard; and it will be found that the diagnosis thus indicated by agglutination alone is confirmed in 21 out of the 22 strains by the authors' subsequent absorption tests. The exceptional case is No. 19 which on simple agglutination, reached 10,000 with *suipestifer* serum as against 2,000 with *paratyphosus* serum; the absorption results, however, are ambiguous, as absorption of *suipestifer* serum with *paratyphosus* reduced the agglutinin for this strain from 10,000 to below 100, whilst absorption of *para-*

typhosus serum with *suipestifer* also effected a marked reduction in agglutinin for the strain (from 5,000 to below 200).

On this view, the fact that all the strains investigated had been well authenticated may have been a disadvantage, because it may mean that they had been selected as "typical" owing to their conformity with one or other of two well known serological criteria. If this was the case, Uhlenhuth's objection against the absorption method has not been refuted. On the other hand, supporters of the absorption theory may regard Uhlenhuth's laboratory data as inconclusive. It will be best, therefore, to leave the question as still unsettled. Evidently these intestinal organisms show a tendency to serological grouping, just as meningococci do, and they may possibly be capable of subdivision into two large groups supplemented by a number of smaller ones. But, as the groups have not yet been fully worked out, one cannot take it for granted that the members of some of them will be exclusively "suipestifer" and the members of others exclusively "paratyphoid."

These considerations of laboratory detail are important because they have a direct bearing on a general question of bacteriological classification, which concerns the meningococcus and many other organisms, in addition to *paratyphosus* (B) and *suipestifer*.*

How much stress ought to be laid on individual peculiarities of particular strains? There can be no doubt that in many, if not in all, widely distributed groups of organisms such peculiarities do exist; and this fact is usually brought into prominence whenever the stimulus of research leads to minute examination of a large number of organisms belonging to the same class. Then the difficulty of standardisation arises. The obvious course is to begin with a particular strain as a provisional standard and see how many other strains coincide more or less completely with this, in agglutinating with and absorbing agglutinin from the serum produced by the standard strain. If there remains a residue of aberrant strains, a second provisional standard is selected from these, and it is ascertained how much of the residue can be grouped under this second standard. To the strains, if any, which refuse to fall into the second group a similar process is applied, and so on, until all the strains are accounted for.

This method is unimpeachable if it is recognised as being no more than a preliminary orientation; but it is fallacious if it is taken as providing a final classification. Suppose, for example, the orientation method gave three groups, the respective standard strains being A, B, and C. One cannot take it for granted that all the strains in Group I are identical with A in agglutinogenic and absorptive capacities, nor that the same holds good for Groups II and III; but without such

* It is in view of this general question that I have discussed the significance of absorption experiments with food-poisoning organisms; the question of what is the best way to classify these particular organisms would involve consideration of many matters, in addition to absorption experiments, and does not come within the scope of this report.

identity the grouping would not be justified, since the selection of other strains as standards would then give different groups. The true standard is that which represents what exists in nature, and therefore must recognise such individual differences as occur; a standard which ignores these would be arbitrary, artificial, and not truly representative.

To put the same considerations in a more technical form, absorption is supposed to aid classification by bringing out a distinction between specific and non-specific agglutinin; the value of the absorption method must therefore be discussed in relation to theories as to the specificity of agglutinin.

PRINCIPLES DETERMINING DIFFERENTIATION OF AGGLUTININS.

I.—Bacteria of Different Species.

If the agglutinin for each species were quite distinct from the agglutinins for the rest, the matter would be very simple. For example, a serum containing the agglutinins *a, b, c* would be due to mixed infection with the three species A, B, and C; and each species, as shown by Castellani, would absorb its own agglutinin from the serum, leaving the other agglutinins intact.

But it very often happens that there is a partial overlapping, to greater or less degree, of agglutinins produced by bacteria which are recognised, from their general biological characteristics, as belonging to distinct species. On Durham's hypothesis, this fact would be explained by assuming that agglutinin consists of several different components. Thus:—

Species A may produce agglutinin *a b c d e*.
Species B may produce agglutinin *a b f g h*.
Species C may produce agglutinin *b c i k l*.

Accepting this hypothesis, provisionally, the specific agglutinins would be contained amongst the components *d e*, *f g h*, and *i k l*, respectively, whilst the corresponding non-specific agglutinins would be represented by *a b c*, *a b*, *b c*. This distinction would again be demonstrable by Castellani's method; *e.g.*, absorption of an A serum with a B strain would remove all agglutinin for species B but would leave agglutinin practically intact for species A.

This method has often been applied as an aid to diagnosis. For example, an unknown culture X is agglutinated both with serum A and serum B. Serum A is then absorbed with culture X and the absorbed serum is tested upon a known strain of species A. If it is found that X has removed the agglutinin for the known strain, X is regarded as belonging to species A. If this is not the case, a similar test with B serum and a known B strain may show that X belongs to species B.

The validity of this method is widely recognised in cases where a positive result is obtained, *i.e.*, when the unknown strain removes specific agglutinin for either A or B.

It is to be noted, however, that if the result is negative, *i.e.*, neither strain A nor strain B fails to agglutinate with the serum

absorbed by X, it is not justifiable to conclude that X belongs to a third species different from both species A and species B, because a particular strain does not necessarily absorb agglutinin for all members of the same species. In such a case the absorption test would give no information of diagnostic value.

This important fact that strains of the same species may differ from each other in absorptive capacity is well illustrated by the work of Meinicke, Jaffé and Flemming (1906).* They tested the absorptive capacities of 47 cholera strains which were all typical and all agglutinated well, and about equally, with a standard cholera serum; this serum, which had been prepared from one strain, had no effect on "cholera-like" vibrios. Marked differences were found. Some strains absorbed agglutinin for the whole or the majority of the 47 strains; but others only removed agglutinin for a relatively small number, and in this respect they exhibited a selective action, *i.e.*, the strains picked out by some absorbing strains were not the same as the strains picked out by others. This selective action was qualitative and not merely quantitative, because a strain which only removed agglutinin for a few strains could not be made to remove agglutinin for more by repeating the absorption. According to absorptive capacity, their 47 strains might be divided, roughly, into 5 different groups, but the demarcation of these groups was not always sharply defined, and within some of the groups a sub-division might be made. The authors thought that if the number of their strains had been larger the number of groups would probably have increased, but they fully recognised that attempted grouping of cholera strains in accordance with absorptive capacity would be devoid of practical interest.

This irregularity of absorptive capacity is particularly significant, because the cholera vibrio is remarkably specific in agglutinability and agglutinogenic capacity. With other species which are less uniform in the two latter respects, it is still less likely that diagnostic significance can be attached to irregularities in capacity for absorption.

II.—Possible Sub-Groups of one Species.

Whilst the absorption method often gives positive results in determining the species to which an organism belongs, its applicability to the sub-grouping of members of one species, which coincide in simple agglutinability, is another matter. In the former case, its utility consists in eliminating the ambiguity caused by the overlapping of two different sera which contain heterologous as well as specific agglutinin. In the latter case, it is not a question of distinguishing specific from heterologous or accidental agglutinin, but of emphasising those characteristics of the sub-groups which are not common to the species as a whole. Thus, borrowing Durham's conception of

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* Ueber die Bindungsverhältnisse der Cholera-vibrionen. Zeitschr. f. Hyg., Bd. 52, 1906, p. 416.

the multiple components of agglutinin, the sub-groups of a species may behave as follows:—

(*a*)—Group I may produce agglutinin *a b c d e*.
Group II may produce agglutinin *d e f g h*.
Group III may produce agglutinin *d e i k l*.

The special characteristics of each group would be contained amongst the components *a b c*, *f g h*, *i k l*; the agglutinin common to the whole species would be *d e*. This distinction, as in dealing with organisms of different species, would be brought out by the absorption method, but the nature of the distinction would be very different. Here, *d e*, which is common to the three groups, is essential; it is not heterologous and cannot be eliminated as unimportant. Its presence is in no way comparable to the accidental overlapping by *a b c*, *a b*, and *b c*, in the three different specific sera which I have figured above (p. 23).

I wish to emphasise this last point, because much confusion has been caused by loose usage of the terms "specific" and "non-specific." Admittedly, bacteriological "species" are more or less ill defined, but there need be no practical difficulty on that score. For example, gonococci and meningococci are quite sufficiently different to be called different species; differentiation, by absorption, of a gonococcus and a meningococcus which are agglutinated by the same serum is a specific differentiation. On the other hand, cholera vibrios are all sufficiently alike to be included in one species, and the same may be said for typhoid bacilli; differentiation, by absorption, of two cholera or two typhoid strains which agglutinated with the same serum would be a minor distinction, possibly affording a basis for sub-grouping, but not invalidating the evidence of specific relationship afforded by the simple agglutination test.

I have taken the simplest case first, where the sub-groups possess some agglutinins in common and thereby show their relationship to the species as a whole. Here, as Meinicke and his colleagues have shown, sub-grouping is possible by means of the absorption test, but in their experience with strains of cholera it seemed to be of minor importance and in no way corresponded with differences of virulence. Instead of providing a useful basis of classification, the differences in absorptive capacity which they demonstrated proved, in their opinion, that "the Castellani test could no longer be regarded as an infallible criterion."

Then there is another possibility, in the sub-grouping of some species of bacteria, where the sub-grouping is equally simple but of a different kind, being based on the absence of serological affinity between the groups, as shown by simple agglutination tests alone. Thus:—

(*b*)—Group I may produce agglutinin *a b c*.
Group II may produce agglutinin *f g h*.
Group III may produce agglutinin *i k l*.

According to the American investigators referred to above (pp. 10-13), the pneumococcus, excluding the more or less distinct

species *Pneumococcus* or *Streptococcus mucosus,* affords an example of such a species.

In such a method of grouping, as there is no overlapping of agglutinins, resort to the absorption test is not required.

But more commonly, particularly when a large number of strains is examined, the sub-grouping of a species is too complex a task to adapt itself to either of the simple schemes (*a*) and (*b*), and the question arises as to how far absorption is an aid to classification in these cases.

The complexity is due to the fact that the members of each proposed group are not identical in every respect. It is found, for example, that some proposed members of Groups I and II in scheme (*b*) produce, in addition to their special agglutins *a b c*, *f g h*, some further agglutinin, *d* or *d e*, which is common to both groups, as in scheme (*a*). Again, it may be found that other members of a group, *e.g.*, Group I in scheme (*b*), produce less than their special agglutinins *a b c*; some strains, as shown by absorption of the sera produced by them, may possess only the *a b* antigen, or only *a c*, or *b c*, or *a*, *b*, or *c*. Hence the absorption test, at first called in to justify the groups originally postulated, would make the further demand that these groups must again be subdivided.

Put schematically, the position would be:—

(*c*)—Members of Group I may combine with one or more or all of the agglutinins *a*, *b*, *c*, *d*, *e*.
Members of Group II, similarly, with *d e*, *f*, *g*, *h*.
Members of Group III, similarly, with *d*, *e*,.........*i*, *k*, *l*.

Thus the agglutinin for the species as a whole would comprise all the components *a* to *l*, and each member would be identified by one or more of these components. If the individual members could be grouped as in the above scheme, *i.e.*, sometimes with partial but never with complete overlapping of the main groups, grouping would be possible but the main groups would need further subdivision.

But here, as in the simpler case of the cholera vibrio, it is difficult to understand what diagnostic significance can be attached to a classification based on irregularities of absorptive capacity.

III.—A Species not Divisible into Sub-Groups.

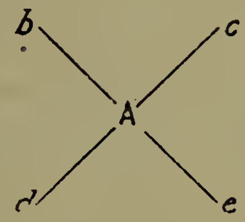
It is not uncommon to meet with strains of bacteria possessing individual peculiarities which simply have to be recognised as such. This is no bar to classification, provided that the characteristic agglutinin for the species or for the sub-group remains demonstrable for every strain. But it is also possible that the members of a species may evince individuality of such a nature that they are not amenable to classification into groups.

As contrasted with Scheme (*c*), it would be impossible in this case to assign certain agglutinins as the exclusive property of one or other of the postulated main groups. Thus:—

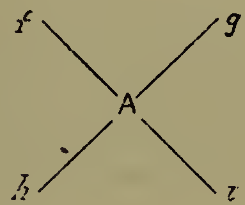
(*d*) The complete agglutinins of the species = *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *k*, *l*. Individual members may combine with only one, or more, or all of these.

But the last scheme would not be a satisfactory representation of the species because it does not bring into expression the underlying unity of specific antigen upon which individual variations are superimposed. It would probably be more accurate to assume that specificity is based upon a common constitution of the protein molecule, to which a variable receptor apparatus is attached. Thus the agglutinin complex of each strain will possess a common characteristic, which may be designated *A*, and this, in the case of different strains, will be associated irregularly with minor elements, *b, c, d, e,* etc., not individually representative of the species as a whole. For example:—

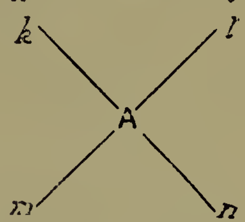
(*e*) Strain (1) may produce agglutinin :—



„ (2) „ „ „

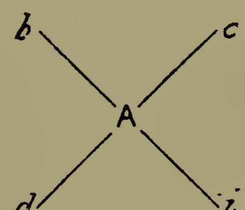


„ (3) „ „ „

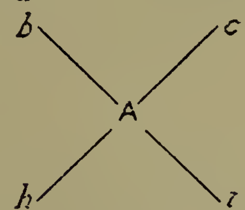


With these three strains *A* is shown as linked to four elements, and each of these is different for each strain. But other and less sharply contrasted expressions of individuality may occur, *e.g.* :—

(*f*) Strain (4) may produce agglutinin :—



„ (5) „ „ „



„ (6) „ „ „

Strains (4), (5), (6) differ less from strain (1) than do strains (2) and (3); and it might be found that the agglutinin produced by strain (1), and therefore combining with strains identical with this, failed to combine with strains (2) and (3) but was able to unite with less divergent strains such as (4) and, though perhaps not equally well, with strains such as (5) and (6).

Similarly with agglutinin produced by strain (2). This might not affect strains (1) and (3) but it might interact with strains less

divergent from, though not identical with, the homologous strain. And the like would hold with strain (3) agglutinin.

Strains (1), (2) and (3) are taken as examples of strains sharply differing from each other, as shown by their respective elements *b c d e, f g h i, k l m n*. Obviously, the number of such strains may be very large: *e.g.*, a fourth may be associated with *b f m g*, a fifth with *c h i k*, a sixth with *d e g l*, and so on. And, as illustrated above, each of these strains may produce agglutinin which will pick out not only strains identical with the homologous but also strains in which the difference from the homologous does not amount to a sharp contrast.

Hence, on testing the strains of this species with a large number of monovalent sera, the broad result would be a reiterated and irregular demonstration of resemblances and differences between different strains. The resemblances would be due to the fact that all the strains belong to the same species; the differences would be the expression of individual peculiarities. Scientific grouping would be impossible because, unlike the species discussed in Section II, the species now under consideration contains an indefinitely large number of strains which differ in qualitative capacity for producing and combining with agglutinin.

IV.—The Question Whether a Given Species is or is not Divisible into Sub-Groups.

It follows from the above considerations that if the strains belonging to the species fall into distinct groups, without cross-division, when tested with an extensive number of monovalent sera, grouping is indicated; but if such tests produce marked cross-division, grouping is not justifiable. For example, sera I, II, and III may apparently divide meningococcal strains into three corresponding groups; but if sera prepared from other members of these groups invalidate this distinction, it may be inferred that the three groups do not represent an accurate subdivision of meningococcus antigen into three distinct and separable types.

V.—General Remarks.

In determining whether a doubtful organism belongs to one or other of certain different species, the absorption method is certainly useful sometimes, as a supplementary test, provided that the result is positive, *i.e.*, that evidence of specific absorption is obtained.

The method has been applied clinically, by testing the patient's serum with bacteria of known species, and has been the means of identifying the bacterial cause of the disease, when the results of simple agglutination were ambiguous, and also of demonstrating cases of mixed infection. There are certain fallacies to guard against, as Paltauf has pointed out. The infection may really be due to an unsuspected organism, which has produced in the patient some heterologous agglutinin for one of the organisms under suspicion. For example, the diagnosis may be thought to lie between typhoid, paratyphoid, and Gärtner infection, and it may

be found that the agglutinin which acts on these three organisms is absorbed by the typhoid bacillus; but the case may really be an infection with *B. proteus,* which has produced some heterologous agglutinin for the typhoid bacillus. But instances such as this do not detract from the fact that the method is admittedly useful. Similarly, when the organism isolated from the patient gives ambiguous agglutination results with laboratory sera representative of different species, a positive absorption test may help to settle the diagnosis.

On the other hand, a strain cannot be excluded from a species because the result of the absorption test is negative. Such cases, where the diagnosis must be determined by the general biological characters of the organism taken as a whole, serve as a useful reminder that serological reactions are not always infallible and do not necessarily play the decisive part in determining classification.

The sub-grouping of a species may turn out to be an easy or a difficult matter. This will depend partly on the homogeneity or the irregularity of specific antigen and partly on the use of a small or a large number of strains for the demonstration of agglutinogenic and combining capacities. It may be found, to begin with, that simple agglutination alone divides the strains into groups with no overlapping, as in Scheme (*b*). If the addition of more strains and more sera confirms this classification, well and good. If, however, it is now found that there is some overlapping, as in Scheme (*a*), resort will be made to absorption. This, possibly, will still support the original grouping, which will now be an amalgamation of Scheme (*a*) and Scheme (*b*). It may turn out, however, that in the enlarged series further differences of antigen are found between members of the same group, as in Scheme (*c*). Even now it may still be possible to provide a theoretical justification for the original groups, supplemented by a subdivision of each, provided that there is no more than a partial identity between the postulated complete antigen of each of the three main groups; though it hardly seems likely that such an elaborate classification would be of diagnostic value. At this stage, where each main group is so elastic that its margin of separation from the others is small, one begins to raise the question whether the adopted system of grouping has not turned out to be artificial and arbitrary, and whether the species under consideration is really distinguishable from one which is not amenable to sub-grouping, as in Schemes (*d*), (*e*) and (*f*). One's decision will naturally be influenced by observing whether the proposed grouping does or does not involve the confusion of cross-division.

DIFFERENTIATION OF AGGLUTININS IN RELATION TO THEORIES OF IMMUNITY.

For the above discussion I have taken as the starting-point Durham's hypothesis of a multiplicity of agglutinins in monovalent immune sera, because his views are well known and have obtained wide, though not universal, acceptance. Like all other explanations of immunity which are based on Ehrlich's principles, Durham's theory postulates an indefinite or unlimited number of

unknown chemical components, and on this ground it may be open to the objection, which has been raised against many of Ehrlich's postulates by the opposing school of Bordet, that this free coinage of hypothetical chemical entities is merely a restatement of laboratory data in terms of the unknown, a resort, in fact, to the fallacious method of exposition known as *ignotum per ignotius*.

Perhaps there is some element of truth in this objection. For example, one might be tempted to begin by postulating that a particular agglutinin contained the components *a*, *b*, *c*; when laboratory facts came to light which showed that this explanation was insufficient, another component, *d*, might be tacked on to it; and this, when further occasion required, might be supplemented by *e*, *f* *g*, etc. Obviously such postulates would be no real explanation but merely a redundant way of saying that the phenomena of agglutination are complex and of unknown nature.

At the same time one must recognise the importance of Ehrlich's general principle that the specificity of agglutinins is determined by their precise chemical constitutions, though these are too imperfectly understood to be expressed in the rational formulæ of the organic chemist. This chemical conception, though unfortunately vague, cannot be ignored, because specificity cannot be explained on purely physical grounds; it must, however, be supplemented by the equally important conceptions of immunity which are based on experimental physics and the properties of colloids, since these principles, whilst not explaining specificity, play an essential part in agglutination.

The difficulty of Ehrlich's theory, it appears to me, is twofold; it is exclusively chemical and much weakened by controversial antagonism which refuses to recognise the value of physical theories; and the chemical conceptions follow too closely analogies derived from the study of aniline dyes and experimental pharmacology. One needs a theory which will link up the chemical and the physical sides of the problem, instead of making them appear irreconcilable; and it is doubtful if the groups and side-chains which determine the properties of dyes and drugs are analogous to the differences in chemical structure which determine the differences of various antigens and antibodies. The fact that neither a purely chemical nor a purely physical theory will suffice is emphasised by Paltauf, who has reviewed with remarkable impartiality conflicting theories as to the nature of agglutination.* He concludes:—"Agglutination (and precipitation) is a genuine colloid reaction, but for the specificity of this reaction the chemical constitution of the interacting colloids is responsible. This determines the formation of the complex combinations which are associated with alteration of the conditions of solubility, and, by altering surface tension, determine the process of clumping."

The problem has been simplified by Bordet's conception, which has now been accepted by the majority of observers, that the agglutination reaction takes place in two phases, the first being "the period of impression" and the second "agglutination properly so called."

The result of the first phase is that a change takes place in the colloidal nature of the bacteria; this change involves, according to some physicists, with whom Paltauf appears inclined to agree, a conversion from the emulsoid into the suspensoid form. Then, coming to the second phase, there is an interaction between two colloids (bacteria and serum) in the presence of salts, with consequent agglutination, if this is compatible with the physical condition of the bacterial colloid.

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* Kolle and Wassermann's *Handbuch der pathogenen Mikroorganismen.* 2nd Ed., vol. 2, Pt. I, pp. 483-654. 1913.

This view of Bordet's, now well established, serves to clear the ground and enables one to concentrate attention on the first phase, in which the specific interaction between antigen and antibody takes place.

Here chemical constitution must play a part, as it is difficult to see how physical conditions alone can determine specificity. The postulate of "specific absorption" merely postpones the difficulty, as the specificity of the interaction must depend on chemical constitution. Durham's conception of antigen and antibody as possessing a multiplicity of different chemical groups is at least chemical; and on this ground, it might be urged, it ought to be accepted until something better can be found to replace it. One way of emendation, advocated by some bacteriologists, is to introduce the conception of differences in "avidity" on the part of particular antigens. On this assumption, two conditions are necessary for the union between a particular antigen and a particular antibody, (1) appropriate chemical constitution and (2) the character termed "avidity." (1) is not necessarily accompanied by (2); when it is not, union with antibody does not take place. The general conception of specific antigen and antibody as containing a large number of different chemical groups is retained.

I have already referred (p. 24) to the observations of Meinicke and his colleagues on differences in the absorptive capacities of cholera vibrios. Following Durham's hypothesis, one might endeavour to explain these results as in scheme (*a*) on p. , viz. :—

Group I. may contain antigens *a*, *b*, *c*, *d*, *e*.
,, II.—may contain antigens *d*, *e*, *f*, *g* *h*,
,, III may contain antigens *d*, *e* . . .*i*, *k*, *l*.

The strains agree in agglutinability because they all possess the antigens *d*, *e*, but they differ in absorptive capacity owing to the presence or absence of certain other antigens; *e.g.*, absorption with a Group I strain will remove all agglutinin for members of this group, but not for strains containing any of the antigens *f* . . . *l*.

But against this explanation there are two objections. (1) The strains agree in agglutinability not merely with the same serum but with different sera; *e.g.*, though Group I and Group II do not absorb for each other, a Group I strain will produce a serum which agglutinates Group II strains and *vice versa*. (2) Under identical conditions of experiment, different strains absorb for themselves the same amount of agglutinin from different sera. (1) indicates that the different groups have not been found to differ qualitatively, *i.e.*, as regards the presence or absence of particular antigens; and (2) shows that they have not been found to differ quantitatively as regards the amount of particular antigens possessed, *i.e.*, it cannot be postulated that Group I strains possess all the antigens of the three groups (as shown by agglutinogenic capacity), but possess certain of these antigens in much smaller amounts than the other groups (as shown by lack of absorptive capacity); for if this were the case the amount of agglutinin which a strain absorbed for itself, under the same conditions of experiment, would differ according to the group-membership of the strain used for preparing the serum.

Meinicke and his colleagues meet this difficulty by postulating differences in "avidity." All their strains, they argue, possess all the cholera antigens, say *a* to *m*, but *in vitro* some of these elements lack "avidity" (capacity for combining with the corresponding agglutinin); thus, for one strain the only "avid" elements may be *a*, *b*, *d*, *k*, *m*; for another the elements *c*, *e*, *f*, *n*, and so on. *In vivo*, however, the greater disintegration which takes place in the animal tissues releases all the antigens in an active condition, and consequently a serum is produced which contains every representative agglutinin.

This postulate of "differences in avidity" amongst different

components of an antigen appears to me unnecessarily complex. I think the element of truth it may contain would be better expressed by a broad recognition of the fact that the combining capacities of antigen as a whole are affected by its particular chemico-physical condition.

Meinicke's experiments may then be regarded as showing that cholera antigen is one and the same, in essential chemical structure, and so is cholera antibody, but minor differences exist *in vitro* and are brought out by the absorption test. This fact may be explained, not by representing a specific antigen as consisting of several different components coexisting side by side, but by regarding it as a chemical substance which may exist in one or other of several different chemico-physical phases, demonstrable by test-tube experiments. And the same conception would apply to antibody. Thus, when cholera culture and antiserum are brought together, the amount of culture being sufficient to remove the whole of the agglutinin with which it is capable of combining, the cholera antibody is affected as a whole by this interaction and any that is left uncombined settles down into equilibrium by a process of readjustment, involving such changes as constitute a new chemico-physical phase. The residual agglutinin, owing to its change of state, can only combine with such cholera strains as are in a different chemico-physical phase from the original absorbing strain.

This conception is not inconsistent with Paltauf's view that "according to the nature of the molecule as a whole, certain properties may vary, although the specific reacting group remains the same."

It is a conception which implies varying complexity in the structure of one and the same specific substance; it differs from the conceptions of Meinicke, Durham and others, which imply that specific substance is not one but multiple, and that each component is separable from the rest.

At this point it will be useful to give more definite significance to the term "chemico-physical phase" by reference to experimental facts. Apart from changes affecting only the second stage of the agglutination reaction, *i.e.*, changes in agglutinability without changes in absorptive capacity, variations have often been found in the absorptive capacity of the same strain under different conditions. Sometimes this change of condition is definitely due to a physical, chemical, or physiological influence and sometimes, when the reason of the change is unknown, one can only say that apparently spontaneous variations are found in nature.

As an example of physiological influence, artificially introduced, I may refer to the well known fact that changes are often produced in bacteria by cultivation in immune serum. P. Th. Müller (1903),* for example, found that the agglutinability of typhoid bacilli was lowered by growth in immune serum and that this change was accompanied by a diminution in absorptive capacity. But this change, as Paltauf points out, does not always result from the action of immune serum. Some observers have found diminished agglutinability without diminished absorptive capacity; others have found no change in agglutinability; and others again have observed that strains cultivated in immune serum acquire the property of spontaneous agglutination. As another example of physiological influence, it may be mentioned that the characters of an immune serum often depend to an important extent upon the species of animal used for inoculation.

As regards purely physical influences, the effect of heat is the simplest example to take. The very extensive literature on this subject may be briefly summarised by saying that exposure of a culture to a temperature above the normal may enhance, impair, or otherwise modify agglutinability, agglutinogenic capacity, and absorptive capacity.

Altmann and Rauth (1910)† give a suggestive example of modification in

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* Münch. med. Wochenschr., p. 13.

† Zeitschr. f. Immunitätsforschung. Orig. Bd. 7, p. 629.

serological properties produced by chemical means. With a particular strain of *B. coli* they produced a serum which, in agglutination and complement deviation tests, responded to the homologous strain alone. This strain, as shown by a month's passage on agar, remained stable and on separating out individual colonies it was found that all were serologically alike, being identical with the original strain. The strain was then treated by passage on carbol-agar, with the result that it lost its agglutinability. A serum was prepared from it and was found to agglutinate the carbol-strain but not the original strain. The properties of the new strain remained constant when the subcultures were made either on ordinary agar or on carbol-agar. Repeat experiments (three with one strain and one with another) produced similar serological modifications by passage on carbol-agar. During passage and before the change had been fully effected, a strain would react both with the ordinary serum and with the "carbol"-serum, and whilst in this transitional condition a strain would produce a serum agglutinating both kinds of culture. Three kinds of colonies could be obtained from such a strain, some reacting like the whole strain and others only with one or other of the two sera. The authors also found that somewhat similar changes could be produced in strains of *B. coli* by prolonged subculture in ordinary broth, the effect being that they lost their agglutinability with the original serum and sometimes became agglutinable with the "carbol"-serum. They suggest that the indol produced in the culture acted in the same way as phenol.

Bacteriological literature is full of examples of what may be termed natural irregularities or spontaneous variations. Perhaps two quotations will suffice for the purpose of illustrating this point.

Rufus Cole (1904)* illustrates differences in agglutinability of different strains of typhoid bacilli. He selected five laboratory strains, designated E, H, I, W and C, and ascertained their highest agglutinations with a particular serum. The results were:—E=8,000; H=7,000; I=4,500; W=4,500; C=4,000. He then prepared a serum with I, one of the poorer agglutinators, and found:—E=3,000; I=700; C=500. Then he prepared a serum with C and found it agglutinated E up to 3,000 but only reached 2,000 with C. Finally he compared the absorptive capacities of good and poor agglutinators on a serum which agglutinated E up to 5,000. Four absorbing strains were used and reduced the titre for E as follows:—E=200; H=500; W=1,000; C=1,000. Thus, as Cole points out, higher agglutinability was associated with greater binding capacity, and relatively poor agglutinability was a consistent feature of some of the strains even when these strains were used for the preparation of the serum. An interesting feature brought out by this short series of experiments is that the differences demonstrated between the good and the poor agglutinators are not such as to afford a basis for "serological grouping."

I have quoted this article because, although it only deals with a small amount of material, it exemplifies very well the experience of other observers on a large number of strains.

Sobernheim and Seligmann (1910)† call attention to biological variations in strains of *B. paratyphosus* (B) and *Gaertner*. They point out that if a laboratory only uses one standard serum for each of these groups of organisms, new strains can generally be accounted for, though with some exceptions. But the results are much more complicated if a large number of strains are tested simultaneously with a large number of sera. Their observations are based on examination of 100 paratyphoid and Gaertner strains and 60 sera.

As regards the Gaertner group, they found that a high titre serum agglutinated only a certain number of strains; others were slightly affected, and many others were left untouched. Comparing the individual results with different sera, further differences came to light; the sera failed to tally either as regards degree of agglutination produced or as regards number of strains agglutinated; hardly any of them affected all their strains. Some strains showed changes in course of time in their agglutinability and agglutinogenic properties; they would pass from good into poor agglutinators or the reverse change would occur, and transitional forms were met with. They had two strains which, for a time, were not affected by any Gaertner or paratyphoid serum and produced a serum which agglutinated themselves alone. But these were *bona fide* Gaertner strains to begin with and subsequently reverted to this type, agglutinating with Gaertner

* Zeitschr. f. Hyg., Bd. 46.
† Deutsch. med. Wochenschr., p. 351.

serum up to full titre. Then, when the cultures were plated out and examination was made of separate colonies, agglutinable, inagglutinable, and intermediate colonies were found; and cultures from these exhibited corresponding agglutinogenic differences.

Irregularities and variations were also found in some of the paratyphoid (B) strains. Six strains were typical to begin with but gradually changed in agglutinability. They were then plated out and two kinds of colonies were found, (1) round, translucent colonies which agglutinated like paratyphoid (B), and (2) colonies with granular surface and irregular margin which agglutinated with both paratyphoid and Gaertner serum. Colonies of the second type were plated out four times to confirm their purity, always with the same result; they produced pure paratyphoid (B) serum which had not a trace of influence on Gaertner strains. From another strain, originally an ordinary paratyphoid (B), the daughter cultures were found to be of much lower agglutinogenic power. The serum produced was a pure paratyphoid (B) serum but it only acted on some of the paratyphoid (B) strains and on these, for the most part, not completely; on the other hand, it agglutinated strongly and to high titre not only all the strains which reacted to both paratyphoid and Gaertner sera but also those which had been found to give hardly any reaction with other paratyphoid sera. Finally, from a paratyphoid (B) culture they separated out a strain which was agglutinated by Gaertner but not by paratyphoid sera; but it produced a serum of paratyphoid (B) character, with marked preference for strains in the transitional stage. As the authors remark, the above results show that capacity for binding agglutinin is not necessarily parallel with capacity for producing agglutinin.

The view that certain variations in the combining capacities of antigen and antibody may be attributable to changes in the "chemico-physical phase" of one and the same specific substance leads one to consider the possible influence of minute variations in stereo-chemical structure.

A striking feature about the chemistry of bacteria is that these organisms have a remarkably selective action upon sugars and other allied compounds which are closely related to each other and differ only, or mainly, in stereo-chemical configuration. This selective action, perhaps comparable to the selective action of certain alkaloids, such as brucine, upon sugars which differ only in stereo-chemical respects, may indicate that in the molecules of the bacterial protoplasm there are groupings, linked to asymmetric carbon atoms, which act as "receptors" for the corresponding groupings linked to the asymmetric carbon atoms in the sugar molecules.

This direct evidence of the importance of stereo-chemical structure suggests that differences and affinities of a stereo-chemical nature may also play an important part in the constitution of antigen and antibody and in the relationship of the one to the other.

In this connection one must refer back to the views expressed by Emil Fischer. Writing in 1898 on "The Significance of Stereo-chemistry for Physiology"* he has developed the theory, which he had foreshadowed in 1894, that the selective action of enzymes depends on their asymmetric structure. Though the nature of enzymes is not definitely known, because they have not been isolated as chemically pure compounds, "yet their resemblance to proteins is so great and their origin from the latter is so probable that they must undoubtedly be regarded as composed of molecules which are optically active and asym-

* Zeitschr. f. physiolog. Chemie, vol. 26, p. 60.

metrical. This," he continues, "has led to the hypothesis that between enzyme and fermentable substance a similarity of molecular configuration must exist, if a reaction is to follow. To make this idea clearer I have used the metaphor of lock and key." He is far from regarding this hypothesis as an established scientific theory, and admits that it cannot be fully substantiated until enzymes are isolated in a pure state and their configuration is investigated; but he regards it as a fruitful hypothesis and has found it helpful in the orientation of chemical research.

Fischer's conception is based on his study of the sugars and allied compounds, which has provided extensive corroboration of the principles of stereo-chemistry founded by Pasteur, Le Bel and van't Hoff. Whether the same conception is capable of useful application to immunity problems is another matter; but it is at least worth considering. From the stereo-chemical standpoint, in so far as it may concern immunity problems, some of the salient facts which have been demonstrated by research on pure compounds of known chemical constitution are:—

(1) A pure compound may be produced not only in the optically active forms *d* and *l* but also in forms which are optically inactive. In the case of the latter, inactivation or compensation may take place either externally, *i.e.*, by union of a *d* molecule with an *l* molecule, or internally, *i.e.*, by compensation within the molecule of a *d* group and the corresponding *l* group. A compound inactive by external compensation can be split up into equal numbers of *d* and *l* molecules; but when the compensation is internal, similar dissociation is impossible, as the separation of the *d* and *l* groups would involve the disintegration of the molecule. The four tartaric acids are usually quoted as the classical examples of these facts.

(2) Enzymes often exhibit a selective action upon the *d* and *l* forms of the same optically active compound, fermenting the one but leaving the other unaltered; and their action upon compensated forms will depend upon whether these can be dissociated into active forms.

(3) Pure compounds are found which are almost identical in chemical structure, the only differences being a stereo-chemical difference in the position of groups linked to an asymmetric carbon atom, *e.g.*, the "right-handed" or "left-handed" position of the groups—OH and—H. The best known examples of these facts are found in the sugars of the 6th series.

(4) Enzymes have a selective action on substances differing only in the slight degree mentioned in (3),

There is, I think, reasonable ground for expecting that, when the chemistry of proteins is better known, stereo-chemical conceptions will correct and greatly simplify Ehrlich's very elaborate but highly artificial theory of an indefinite multitude of "side-chains." From the bacteriological side, this line of explanation seems indicated, perhaps most definitely, by the irregularities and the apparently anomalous results such as are often met with in agglutination reactions. Such apparent discrepancies, when irreconcilable with the working hypothesis which the investigator finds suitable to the majority of his data, are sometimes dismissed as negligible. A serum which only agglutinates a few of the strains it was expected to agglutinate is "not useful"; a culture which does not agglutinate with its assumed "standard" serum is "in poor condition"; if in later subculture it behaves as had been expected previously, it has "come up to standard"; if it agglutinates well at first but falls off subsequently, it has "deteriorated"; at all events these little incidents or accidents "don't count."

I admit it would be difficult to account for them by a Jack-in-the-box appearance, disappearance, or neutralisation of fixed chemical groups or side chains constituting the postulated collection of antigens and antibodies; and I think the fact of their occurrence suggests a modification of this conception in favour of the view that, in the interaction of compounds containing asymmetric carbon atoms, many minor changes of a stereo-chemical nature will occur (*i.e.*, changes not involving elimination or introduction of fixed chemical groups), and that these minor changes may often suffice to produce very striking differences in serological reactions.

Some, of least, of the irregularities which have been demonstrated in the agglutination reactions of particular species of bacteria may perhaps be attributed to stereo-chemical differences of one and the same specific substance rather than to the production of an indefinite variety of different chemical components; and these differences may concern agglutinability and agglutinogenic capacity as well as absorptive capacity. Thus there are the differences due to :—(1) *Storage :* when tested with the same serum, a freshly prepared culture emulsion may differ in agglutinability from the same emulsion tested after keeping for same time ; (2) *Heat :* a heated culture emulsion may differ in agglutinability and agglutinogenic capacity from the same culture unheated ; (3) *Subculture :* earlier and later subcultures of the same strain may differ in agglutinability and in agglutinogenic capacity ; (4) *Conditions of growth :* changes may be produced by environment in the animal body or by the nature of the medium used for culture. And the possibility of similar non-specific differences must be considered when comparing one strain with another.

In the last paragraph I have been considering conditions affecting antigens. Possibly analogous differences may exist in the stereo-chemical condition of the specific antibodies to a given organism. Such differences may be due to :—(5) *The animal body :* when animals of different species, *e.g.*, the rabbit and the horse, are inoculated with the same strain, it is found that some of the sera are more multivalent than others, and similar differences are sometimes found between sera from animals of the same species ; (6) *Condition of culture used for immunising :* the sera produced may vary according to the condition of the culture as regards (1), (2), (3) and (4) ; (7) *Storage of serum :* a serum may deteriorate on keeping. Again, the non-specific conditions (5) (6) and (7) must be considered when comparing the specificity of different sera.

Furthermore, in the reaction between antigen and antibody, varying stereo-chemical conditions of the two substances may suffice to explain some irregularities in tests for absorption of agglutinin. When the optically active part of a simple organic compound is inactivated in its behaviour towards polarised light by the presence of its geometrical counterpart, this inactivation may be (*a*) either complete or partial and (*b*) either readily annulled (external compensation) or firmly fixed (internal compensation). Similarly, the union of agglutinin with antigen may be (*a*) either complete or partial and (*b*) may be firmly fixed or may lead with greater or less readiness to a stereo-chemical re-arrangement.

This stereo-chemical view of the conditions which play a part in determining the chemico-physical and specifically chemical interaction between antigen and antibody in the first phase of the agglutination reaction leads to a comparison between the interaction of antigen with antibody and the interaction of a ferment with a fermentable substance. In the latter reaction, the feature which is commonly conspicuous is that union between the two substances and consequent chemical alteration of the one (the fermentable substance) is followed by complete, or almost complete, dissociation, leaving the ferment free to act upon more fermentable substance; thus a small amount of ferment may, so long as the medium remains favourable for

the reaction, and until a condition of equilibrium has been established, act upon an indefinitely large amount of fermentable substance. In the case of antigen and antibody conditions are different in one important respect, in that antigen is unable to combine with or modify an indefinitely large quantity of antibody, and the amount of combination effected depends, *ceteris paribus*, on the amount of antigen present. When the absorbing strain is used in sufficient amount, it renders the serum incapable of agglutinating a further supply of the same strain, or of other strains which are identical in every chemico-physical detail, just as a medium upon which an enzyme has exerted its full effect will not be influenced by the introduction of a fresh supply of the same enzyme. It will be noted that in making this comparison I think it advantageous to regard the enzyme as comparable to the antigen rather than to the antibody.

This result, the removal of a certain agglutinating capacity from the serum, must involve a chemical interaction taking place in the first stage of the agglutination reaction, because cultures which are devoid of agglutinability, either naturally or as a result of experimental treatment, often retain their capacity for "binding agglutinin."

Taking chemical considerations first and postponing the question of physical influences, the usual, and generally the most convenient, way of expressing the experimental facts is to say that the culture removes agglutinin from the serum. This may be true, but it does not follow that it is accurate to regard antibody as a mixed collection of assorted goods from which a culture removes a greater or smaller number of articles and leaves the rest as they were before the reaction took place. The interaction, when absorption takes place with excess of culture, should probably be regarded not as a simple subtraction of certain fractional parts of antibody but as involving partly a combination with antibody and partly a modification of the residuum, and resulting in a new phase of equilibrium which allows antigen to persist in the uncombined state when in the presence of the modified antibody which remains.

This modification of antibody occasionally manifests itself in a paradoxical manner, when it is found that a serum absorbed with a particular strain gives a higher titre for some other strain than it did before absorption. Obviously, in this case absorption has not been a process of simple subtraction of agglutinin, and it is not very helpful to call it a subtraction of an inhibitory influence ; it seems rather a change of "chemico-physical phase" in the direction of increased activity ; and in other cases, where the titre of the absorbed serum is unaltered for some strains and greatly or slightly diminished for others, the changed state of residual antibody is an experimental fact but the postulate that some fractions of antibodyhave been removed and others left "just as they were" seems too crude to be likely to be true.

Fischer's "lock and key" metaphor, as employed by him in a strictly stereo-chemical sense, certainly seems helpful in the interpretation of immunity reactions, if applied in the right place. In the first stage of agglutination the union of antigen and antibody may be regarded as determined by their stereochemical configuration, like the union of enzyme and ferment-

able substance, though antigen is incapable of uniting with an indefinitely large quantity of antibody, because union is not followed by simple dissociation (catalytic action). The union appears to be associated with the production of stereo-chemical changes in the residual antibody which render impossible any further union with the particular stereo-chemical type of antigen employed.

At the same time it must not be assumed that this conception will explain everything. There are not only qualitative, or stereo-chemical, but also quantitative differences of absorptive capacity, the latter probably of a colloidal or physical rather than of a chemical nature. Here it is difficult, if not impossible, to draw a sharp distinction between the first and the second stage of the agglutination reaction. When the reaction has been completed, three facts usually stand out prominently. (1) For the production of agglutination some strains require more agglutinin than others, as shown by differences in titre. (2) The amount of agglutinin removed in "saturation" experiments is more than enough to have agglutinated the whole of the culture used, *i.e.*, a much smaller quantity of serum would have been sufficient for agglutination. (3) The quantity of culture required to "absorb" the same amount of agglutinin often differs with different strains.

These facts suggest physical as well as chemical influence. As the reaction is a lengthy process, as compared with the prompt interaction of simple chemical compounds, it may be considered that the "period of impression," as well as "agglutination proper," requires considerable time for its completion, though it may commence immediately, and also that the physical factors characteristic of the second stage begin to exert their influence before the process of chemical union, characteristic of the first stage, has come to an end. In other words, the "period of impression" may be associated with physical absorption as well as with chemical interaction.

Hence differentiation by absorption is not a purely qualitative criterion in the chemical sense, because the results obtained are partly determined by quantitative or physical conditions. In so far as the latter can be disregarded, the more strictly chemical conditions emerge more clearly, viz.:—(1) the presence of antigen and antibody which are *specific*, in that they are of definite chemical constitution, but may exist in one or other of several different geometrical shapes; (2) the *special* stereo-chemical condition of antigen and antibody which determines whether, "like lock and key," they can approach each other closely enough for the production of a chemical reaction.

If it be possible, as suggested in the preceding discussion, to reconcile the fundamental principles of Ehrlich and Bordet by the connecting link of stereo-chemistry, conceptions of classification by serological reactions will need revision.

Owing to the extreme complexity of the chemical substances concerned and the lack of accurate knowledge as to their nature, this is a problem which is very far from solution; but, though direct chemical analysis of antigen is at present impossible,

some advance in this direction may be made on the bacteriological side by analysis of the serological effects attributable to those variations in the structure of antigen which are probably of a stereo-chemical nature.

Detailed study of agglutination, absorption of agglutinin, and agglutinogenic capacity has already proved of value by showing the complexity and variability of serological reactions amongst different members of one species, particularly when many strains and many sera are used and compared. Some strains exhibit one phase of this complexity and some another; and so strains may be sorted out into a considerable number of groups (overlapping to greater or less extent) according to the phase which each exhibits. The number of groups will depend on the number of strains investigated and on the range of serological tests employed; it will increase from time to time as the investigation assumes wider dimensions. Meinicke remarked about the grouping of his cholera vibrios by absorption tests that such a classification is of no practical utility. But the demonstration that such serological differences are forthcoming serves two useful purposes; (1) it shows the unity, underlying minor differences, which characterises members of a species; and (2) it shows that the erection of these minor differences into class distinctions, attributable to the presence of distinct and separable antigens, would lead to such a large and confusing subdivision as to invalidate the hypothesis on which it was based.

As Uhlenhuth and others have remarked, confusion may not arise if attention is limited to a small number of stock laboratory strains and a few sera; some of these strains might absorb homologous agglutinin from one serum and the rest might absorb it from a second serum, and so no more than two groups would need to be postulated. The confusion comes into prominence when a large and unselected series of freshly isolated strains of a species are fully tested in all their serological capacities.

It must also be borne in mind that serological differences brought out by agglutination tests, though of minor importance in some respects, may be associated with differences of an antitoxic or antibacterial nature, and so may possibly give a clue to the selection of sera for therapeutic purposes.

It is generally agreed that for some organisms, such as the cholera vibrio, antibody is of a simpler nature than is the case with many other species of bacteria wherein strains differ from one another in both agglutinability and agglutinogenic capacity. Here again it may be possible to borrow an analogy from organic chemistry. If the simpler antibody be compared to a sugar of the 6th series, say glucose or galactose, the more complex antibody may perhaps be compared to one of the higher sugars, say lactose, which can be split up into simpler sugars (in this case into glucose and galactose). The species with the complex antigen may produce corresponding agglutinins which reveal a strong indication of division into two groups, though closer enquiry may show that these groups are not sharply separable, and that some strains possess characteristics of both groups. That is what might be expected from a "lactose" antigen or antibody which, under varying conditions affecting its stability, might present resemblances sometimes to

glucose, sometimes to galactose, and sometimes to both. That might explain why a strain might not be consistently "glucose" (or "galactose") in both agglutinability and agglutinogenic capacity.

As regards differences between agglutinability and absorptive capacity (agglutination with a certain serum but failure to remove agglutinin for the strain producing the serum), the explanation might be referred, as with the less complex cholera vibrio, to stereo-chemical variation.

Practical Significance.

These theoretical questions have a direct bearing on diagnosis by agglutination tests, particularly concerning the application of Castellani's method to problems other than those of mixed infection.

In a mixed infection, *e.g.*, one produced by two organisms, A and B, of undoubtedly different species, everyone would concede that two different antigens are concerned, with correspondingly different antibodies, and that Castellani's method of separating them out is often useful, particularly when there happens to be some accidental or at least non-specific interaction between A antigen and B antibody. In such a case there is no urgent need to formulate any particular theory as to the nature of the reaction. Admittedly, antigen is a very complex substance, and so is antibody; the question whether the interaction takes place between A as a whole and B as a whole (with resultant changes in residual A and B) or merely between one separate non-specific component of A and another similar component of B (residual A and B being unaffected) need not be answered, because either alternative would be in accordance with Castellani's results.

But with two strains known to be of the same species, e.g., two cholera strains, wherein absorption tests revealed differences between the two antigens, one's theoretical conception of the interaction between antigen and antibody must be substantiated. Here there is no justification for the assumption that the differences are due to the presence of a non-specific component in the antigen of each strain. Such an assumption would soon be found to be untenable if applied to a large number of strains of this species; so many components of antigen would then turn out to be non-specific that ultimately no demonstrable components of specific antigen would be left.

Still more necessary is it to challenge underlying theoretical assumptions as to non-specific components in dealing with a case presented for diagnosis, i.e., in answering the question whether an unknown organism can be proved to be of different species from a known organism by the adoption of the Castellani method. If this question is seriously *sub judice*, one must give the organism in question the benefit of a fair trial, and therefore one must recognise the validity of the plea that the unknown and the known organism may be of the same species though differing, like cholera vibrios, in absorptive capacity.

Hence, in dealing with organisms which may possibly be of

the same species, in virtue of their morphological and cultural identity, one cannot accept any deductions from theoretical considerations of immunity which are so framed as to permit an arbitrary sorting out of the agglutinins produced by such organisms into specific and non-specific components.

Observations by Drs. Griffith and Scott.

I will now bring my discussion of the absorption test into relation with the observations made by Dr. Griffith and Dr. Scott.

Dr. Griffith has shown that simple agglutination tests suffice to effect a rough division of meningococci into two main groups, provided that carefully selected sera are used; but this division cannot be strictly maintained with all sera, because the grouping produced by some would be different from that produced by others. His explanation is that the grouping, being based on a response to the predominant agglutinins contained in the serum, is determined by the antigen used to produce these; but strains, though alike in agglutinability with the selected "group" sera, may differ from each other in the properties of their antigens and hence may produce different agglutinins. This rough grouping has, however, been found very useful for orientation purposes, before proceeding to a more precise analysis of antigen. In comparing cerebro-spinal with naso-pharyngeal strains, it has brought into prominence the fact that, whereas the two collections of strains are about equally represented in Group II, representatives of Group I are common in the former collection but rare in the latter.

If the system of grouping were infallible, one might infer that Group I antigen is rarely present in the naso-pharyngeal meningococcus of the non-contact. But as the system is far from being perfect, a second alternative has to be considered; the naso-pharyngeal meningococcus may contain Group I antigen and its presence may be demonstrated by the use of other sera prepared from cerebro-spinal strains containing that antigen. Three such sera have been made by Dr. Griffith and have been found to agglutinate several naso-pharyngeal strains strongly enough to indicate the presence of Group I antigen in these.

This last observation furnishes a clue to the analysis of antigen which Dr. Griffith has followed up in his study of agglutinogenic capacity. Sera were prepared from six naso-pharyngeal strains, none of which could be identified with Group I by simple agglutination tests. The sera, however, gave good agglutination with several cerebro-spinal strains in both groups and exhibited a more uniform influence on those belonging to Group I; they generally failed to agglutinate the naso-pharyngeal strains which were agglutinated by the standard Group II serum, but were fairly consistent in agglutinating those naso-pharyngeal strains which were not affected by this serum. Tests for agglutinogenic capacity, therefore, show that certain naso-pharyngeal strains possess both Group I and Group II antigens. Similar characters have been demonstrated

for a few of the cerebro-spinal strains which could not be classified by simple agglutination as either Group I or Group II.

Dr. Griffith's next step in the analysis of antigen was to resort to the absorption test, which, he finds, gives more precise information than simple agglutination as to the combination of agglutinin and antigen and defines more clearly than the agglutinogenic test the degree of relationship between the antigens of different strains. Taking 22 spinal strains of Group I and testing them with six sera, he has found that they differ in range of absorptive capacity. Some strains remove from the sera all the agglutinins demonstrable, which he designates A, B, and C; other strains remove C only, others B and C, and others A and C. These results he has confirmed by increasing the quantities of culture used for absorption; as the differences remained unaffected, he concludes that they are qualitative and not quantitative in character. Corresponding to these differences he postulates three components, A, B, and C, in the antigen of Group I strains. From a similar analysis of Group II spinal strains he has shown that there are at least four different Group II agglutinins.

On comparing naso-pharyngeal and cerebro-spinal strains as regards combining capacity, he finds that those of the former origin which agglutinate well with Group II spinal sera also exhaust the homologous agglutinin of one or more of the four representative sera.

Of the remaining naso-pharyngeal strains, a few, which were agglutinated by Group I sera, have been found to absorb one or more of the three Group I agglutinins.

There is, however, a larger residue of naso-pharyngeal strains which could not be classed by agglutinability as either Group I or Group II. By means of the absorption method, taken in conjunction with agglutinogenic tests, Dr. Griffith has shown that several of these possess components of both Group I and Group II antigen. In this respect they resemble two spinal strains which also failed to agglutinate distinctively with Group I and Group II sera and were unable to absorb any of the three components of Group I agglutinin.

The observations which I have briefly summarised in the preceding paragraphs enable Dr. Griffith to expand his conception of the nature of meningococcus antigen. He regards it as a substance which all meningococci possess in common, irrespective of their origin and irrespective of their classification as Group I, or Group II, or indeterminate. But it is a complex substance and different strains manifest its complexity in different degrees and in different ways. In some strains, which cannot be grouped either as I or II, he regards antigen as being in its least complex phase, with the Group I and the Group II elements about equally balanced. In others complexity is increased by a preponderance of one, two, or all three of the Group I elements designated A, B and C. In others, again, there is a similar preponderance of one or more of the elements characteristic of Group II. Underlying these differences, however, there is the same specific substance possessed by all strains

in common; and it is the presence of this which explains why strains which differ markedly in agglutinability can be shown to be inter-related by agglutinogenic and absorption tests.

In support of this view Dr. Griffith calls attention to modifications in antigenic capacity which some of his strains have exhibited in the course of sub-culture. These changes, he considers, can be explained as modifications of a primary antigenic substance in one or other of two directions, involving increase or diminution of complexity. A similar conception, he holds, would explain changes in antigenic characters which may be attributable to the influence of the human tissues and are characterised in cases of cerebro-spinal fever by the acquired capacity of invading the meninges, a capacity which appears to be much more capable of development in strains possessing the Group I type of antigen than in strains with the less complex antigens which cannot be relegated either to Group I or Group II. These modifications of antigen may, he suggests, run parallel with the curve charting the course of an epidemic, increased complexity of antigen being associated with the upward curve and decreased complexity with the downward curve.

In commenting on Dr. Griffith's observations I think it will be useful to call attention to the differences in mental attitude which bacteriologists have adopted towards the absorption test. Some observers, impressed by the fact that this test is often a valuable aid to diagnosis, emphasise, and perhaps over-emphasise, its value as a bacteriological criterion. On the other hand, there is a school of bacteriologists who emphasise, perhaps unduly, the marked differences in absorptive capacity which may be exhibited by strains undoubtedly of the same species; hence they are disposed to minimise the value of the method for diagnostic purposes. I think Dr. Griffith's work will help to bring about a reconciliation between these opposing views. He has shown that the absorption method is of great value in throwing light upon the structure of antigen; but, as the structure is complex and liable to variation, great care is requisite in the interpretation of absorption results. On the other hand, he does not find that absorptive capacities are so irregular as to be unsuitable for scientific analysis; he shows that their variations appear to be determined by definite principles, and that they are capable of a classification which is systematic though as yet incomplete. He considers that the variations are dependent on minute changes of structure; these, I have suggested, may be largely determined by conditions of a stereo-chemical nature. I agree with his view that the changes can be explained as modifications of a primary antigenic substance; and I think this explanation is preferable to postulating the introduction from without of an antigen originally alien to the strain, or the removal from within of an antigen which the strain originally possessed.

Dr. Scott has made an independent investigation of the same problem, using a different set of strains from those employed by Dr. Griffith. Like Dr. Griffith, he has found that his strains can be roughly divided into two main groups and that the

cerebro-spinal strains are well represented in both groups, whilst the naso-pharyngeal strains preponderate in Group II, but are conspicuously rare in Group I. On minute analysis he finds that this rough subdivision does not suffice for a complete classification of the strains he has examined. Simple agglutination reactions alone afforded an indication that, in addition to the two main groups, there were at least five smaller groups more or less related to Group I and at least two small groups related to Group II. This further subdivision he has confirmed and rendered more precise by the application of tests for the absorption of agglutinin. But the adoption of this classification for practical purposes was found to be confronted by two difficulties; variations in agglutinability and absorptive capacity were so great as to make the classification uncertain, and some strains were found, both spinal and pharyngeal, which could not be placed as serological members of any of the groups. Hence Dr. Scott concludes that it is impossible to regard his types or groups as representing distinct classes limited by hard-and-fast lines.

I agree with this last conclusion of Dr. Scott's. In other respects I regard his results as being confirmatory of Dr. Griffith's in their bearing on the diagnostic significance of serological reactions. Where the results of the two observers do not tally exactly, the differences are probably attributable to the use of different sera. For example, Dr. Scott does not appear to have obtained any sera from Group I strains presenting the high degree of antigenic complexity exhibited by some of Dr. Griffith's Group I strains.

CONCLUSIONS.

In my introduction to this report I raised the question whether serological tests could be found which would differentiate cerebro-spinal meningococci from naso-pharyngeal meningococci carried by non-contacts. This question opens out a wide problem, which I have presented as a series of definite issues, following one after the other, and each demanding a practical solution. Reverting to the order in which I set them out, I think the following answers may be returned to the questions raised as to the value of serological tests for the diagnosis of the meningococcus.

(1) How many standard sera would be required? In replying to this question one must first raise objection to the term "standard." Serologically, the meningococcus is unlike such bacteria as the typhoid bacillus and the cholera vibrio which, on the whole, are uniformly good agglutinators and therefore may be expected to conform to a serological standard. The meningococcus is one of many organisms which are much less constant in their response to agglutination tests, no matter what serum is employed, and therefore do not necessarily conform to any serological standard. The more appropriate question would be: How many sera would be required to form a useful aid to the diagnosis of the meningococcus? The answer is that two

sera would suffice for the greater number of strains, provided that the one was a typical Group I and the other a typical Group II serum. There would remain some strains which were not hit off by either serum. If sera were produced from some of these, the number of strains not found amenable to the agglutination test would be diminished, but one cannot say more than that; it would be quite arbitrary and unjustifiable to fix a numerical limit of three, four, or any greater number of sera and to claim that every meningococcus must agglutinate with one or other of these.

(2) Would there be identity of standards in different laboratories? Every laboratory would have a Group I and a Group II serum, but probably the two sera employed in different laboratories would not be identical, as the range of activity of these sera depends to a very important extent on the particular strains used for immunisation. As regards subsidiary sera there would be still less likelihood of identity.

(3) Would simple agglutination tests necessarily be diagnostic? Irrespective of cultural tests, agglutination is not sufficient, because other organisms, *e.g.*, the gonococcus, may agglutinate with a meningococcus serum. With organisms corresponding to the meningococcus in all other laboratory tests, a positive agglutination result is confirmatory, but a negative result, even with several sera, is not decisive.

(4) What is the value of agglutination when supplemented by tests for absorption of agglutinin? A positive result of the absorption test is confirmatory, but absorptive capacities are too irregular to justify any diagnostic significance from negative results.

(5) Is the absorption method valid? The absorption test proves nothing when the result is negative, *i.e.*, negative results do not disprove membership of a species, as indicated by other biological characters.

(6) What is the value of sera prepared with naso-pharyngeal strains from non-contacts? When not identical with sera obtained from cerebro-spinal strains, they demonstrate interrelationship between cerebro-spinal strains and such naso-pharyngeal strains as are not agglutinated by the cerebro-spinal sera available. They show no indications of any serological characters common to naso-pharyngeal strains and distinguishing these from strains of cerebro-spinal origin.

(7) How do theoretical considerations of immunity affect the practical problem of diagnosis? They show that Castellani's principles of differentiation by absorption of agglutinin, taken in conjunction with Durham's postulate of multiple components of antigen and antibody, cannot be regarded as an infallible criterion for the identification of species.

(8) Are serological tests necessary before deciding whether an organism is or is not a meningococcus, *i.e.*, capable or incapable, under favourable circumstances, of producing cerebro-spinal fever? No; cultural tests, if adequately performed, will suffice.

APPENDIX.

The relation of the Board's Bacteriological Investigations to other Recent Enquiries on Meningococcus Carriers.

In my last report I presented a historical survey of the literature up to the end of 1914, *i.e.*, up to the period immediately preceding the epidemic of cerebro-spinal fever in this country. This outbreak has led to a large number of investigations throughout the country, dealing chiefly with the meningococcus problem as it has affected the military forces.

The bacteriological reports on this work, for the year 1915, have been reviewed by a Special Advisory Committee which reported to the Medical Research Committee in 1916.* The Committee states (p. 32) that "a very large part of the work of most of the reporters has lain in the routine examination of the pharynx of contacts with cases of cerebro-spinal fever." It continues (p. 33):—"In contrast to their experiences with the cerebro-spinal fluid, the great majority of the reporters complain of the unsatisfactory results of the methods for determining the presence of the meningococcus in the naso-pharynx. . . . . . . The work is tedious and beset with pitfalls, while its results were often found ambiguous. Two of the reporters, indeed, express a doubt whether the swabbing of contacts is of sufficient value to be worth the trouble involved." On the use of agglutination as a test for the meningococcus, the Committee says (p. 14):—"Some of the reporters have tried this mode of diagnosis. The best methods for its employment were determined some years ago, chiefly by the German workers . . . . . . Most of those who have employed this test seem to have found it capricious and unreliable." And again (p. 33):—"In the present series of reports agglutination has been little used as a confirmatory test, or tried and found too unreliable to be of service. Major Gordon now believes that the methods and special sera which have been introduced at the Millbank laboratories will in future form the most speedy and reliable confirmatory tests available."

Subsequent to the issue of this Committee's report, the work of Gordon and his associates has been brought up to date in a special volume, published in 1917.† The relationship of this work to that conducted in the Board's Laboratory calls for some notice.

The laboratory work done for the military authorities was organised with a view to dealing with a special emergency. Cases of cerebro-spinal fever had occurred amongst the troops and, with the object of preventing the spread of the disease, it was decided to swab contacts and isolate all men found to be carriers of cocci which might be regarded as dangerous. The dangerous cocci were eventually defined as those which were found by every available test, serological as well as cultural, to be identical with meningococci isolated from recent cases of cerebro-spinal fever. Of the contacts examined, those found

* Medical Research Committee. Special Report Series. No. 2.
† Medical Research Committee. Special Report Series. No. 3.

to be carriers of such cocci were to be reported as "positive," the others as "negative." To facilitate prompt diagnosis, a routine procedure of laboratory tests was laid down, and special culture media were provided, together with certain varieties of sera prepared from strains regarded as representative of the different varieties of meningococci discovered in the epidemic then prevailing.

The work in the Board's Laboratory was arranged with a different object in view. Routine work on the meningococcus was limited to the diagnosis of specimens of cerebro-spinal fluid sent by medical officers of health in England and Wales, whilst the carrier question was treated entirely as a research problem, involving enquiry, irrespective of previous bacteriological findings or provisionally accepted opinions, as to the presence or absence of meningococci in the naso-pharynx of non-contacts. Hence there is very little basis for comparison between the results obtained in the Board's Laboratory and the laboratory data furnished to the military authorities.

The investigation of the non-contacts at St. Bartholomew's Hospital will serve as an illustration. When Dr. Griffith and I first found that a considerable number of these patients yielded strains which were culturally indistinguishable from meningococci, we refrained from making a "positive" diagnosis for six months or more, because we considered that the serological reactions of the strains should be fully worked out before arriving at a decision. Again, when certain of these strains failed to agglutinate with sera prepared from cerebro-spinal strains, we did not regard this result as decisive in favour of a "negative" diagnosis, because sometimes meningococci from cases of cerebro-spinal fever, like pneumococci from cases of lobar pneumonia, may fail to agglutinate with any serum prepared from so-called "standard" strains. In short, it was not our business to follow a prescribed schedule of tests which would determine automatically for each strain whether it was to be reported as "positive" or "negative"; the task was to make full investigation of the individual idiosyncrasies of both cerebro-spinal and naso-pharyngeal strains; and it was only when this work had been in progress for about a year that it was decided that the latter strains must be regarded as true meningococci. This delay caused no inconvenience, because no restrictions of any sort were contemplated for the carriers discovered.

I have no hesitation in saying that, if we had been required to make prompt diagnosis according to the schedule of procedure laid down by the military authorities, the "negative" returns would have been more numerous and would have included many cases yielding strains which eventually proved to be undoubted meningococci.

As regards laboratory details, I have already referred (p. 6) to the care needed in the interpretation of negative results. The remarks of Gordon on the fermentation tests* remind me of further questions, which are well worth discussing, as to the value of particular tests for determining that a given coccus is

* Medical Research Committee. Special Report Series. No. 3, 1917, p. 3.

not a meningococcus. The four sugars which Gordon discusses are glucose, maltose, galactose, and saccharose. About the value of the last there is no question, as all bacteriologists are agreed that a coccus which ferments saccharose is, *ipso facto*, not a meningococcus. The other three sugars need more careful consideration.

With galactose, Gordon observes "there has been diversity of experience," and I agree with him that this is probably due "to alteration of this somewhat fragile sugar in steaming." This involves a modification of the position which Gordon held in 1907.* He then maintained that cultural and fermentation tests were sufficient for differentiating meningococci from Gram-negative cocci of the normal throat, without resort to the agglutination test, which he was "quite unable to recommend"; and he regarded failure to ferment galactose as excluding a coccus from the meningococcus group. Now that he has very frankly changed his views in the light of subsequent research, I agree with him that it is better to abandon galactose as an exclusion test. Galactose has been given a trial in the Board's Laboratory but has not been found particularly useful. To avoid decomposition, it should be sterilised separately in 10 per cent. solution before it is added to the medium. It will then be found that the meningococcus consistently fails to ferment it. There may, however, be some advantage in using laevulose instead of galactose. This sugar, which also requires careful treatment to avoid decomposition, is not fermented by the meningococcus, but it forms acid with some strains of *flavus* which fail to attack saccharose.

With both glucose and maltose Lingelsheim found that all his strains of meningococci agreed in giving a well marked acid reaction; and apparently Gordon's experience, as recorded in his earlier work, was the same. If the experience of other observers were in agreement on this point, there would be no disadvantage in omitting the use of maltose, as Gordon has done in his later investigations. But, as I pointed out in my previous report (pp. 10–12), several bacteriologists have found that some strains of meningococci attack maltose much more strongly than glucose; and this fact has been repeatedly confirmed in the Board's Laboratory. Not infrequently a freshly isolated strain of cerebro-spinal origin has failed to give any acid reaction in the glucose tube; a similar result with a naso-pharyngeal strain would obviously not justify the exclusion of the latter organism from the class of meningococci. So I think the use of maltose should be retained.

The above considerations indicate that the fermentation tests require careful handling, and that caution is needed in the interpretation of their results, especially when freshly isolated strains are under investigation. When the requisite precautions are taken, these tests must still be regarded as a useful part of the series of cultural tests which determine whether an organism is a meningococcus.

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* Report to the Local Government Board on the Micrococcus of Epidemic Cerebrospinal Meningitis and its Identification.

In 1907 Gordon was strongly of opinion that cultural tests were sufficient for the diagnosis of meningococci from the nasopharynx, and that nothing was to be gained by supplementing them with serological reactions. I am inclined to agree with this view, provided that the cultural tests are rightly conducted. Since 1907 a large amount of agglutination work has been put on record; and when one takes a broad view of its results, instead of focussing attention upon some particular hypothesis as to serological grouping, it is seen that serological tests afford no basis for excluding from the class of meningococci an organism which has been properly identified by cultural tests as belonging to this species. This view is expressed even more strongly by the Special Advisory Committee which reported to the Medical Research Committee in 1916.* Discussing nasopharyngeal cocci, they say: "We should regard a meningococcus-like organism which gave *all* the cultural reactions of the meningococcus as certainly capable of producing meningitis."

In the same paragraph the Committee say:—

> . . . . it appears to us that the meningococcus is shown to be a good enough "species" in the natural history sense, as species go amongst bacteria. That is to say it can be adequately separated from other Gram-negative cocci by the exercise of reasonable care. By serological means it can be divided up, it is true, into certain immunological races or strains, as will be mentioned a little later, but this need not affect its specific entity.

On p. 15, where they discuss the diagnostic value of serological reactions, they remark:—

> The German observers endeavoured to prove that the strains found in the throats of non-contacts were "pseudo-meningococci," but they were unable to frame any definition of a pseudo-meningococcus which would not include some undoubted spinal strains. No serum has ever been produced which will certainly distinguish between the genuine organism and the so-called pseudo-meningococcus.

And they add:—

> The evidence which has so far accumulated suggests that comprised under the term meningococcus there are a number of races, differing in their immunological reactions, some apparently more virulent than others, but there is so far no justification for asserting any to be destitute of potential pathogenic powers. How sharply defined and stable these races may be we do not at present know.

The above opinions, it appears to me, present a cautious and accurate review of the position established at the beginning of 1916; and their accuracy is confirmed by the results of subsequent work in the Board's Laboratory, as shown in the present series of reports.

To recapitulate, cultural tests are sufficient for the diagnosis of the meningococcus; confirmation by serological tests, which indicate a subdivision of meningococci into different serological races, is not necessary for deciding whether an organism belongs to the meningococcus species.

This position is quite compatible with the view, now held by the majority of investigators who have studied the subject, that the serological characteristics of meningococci are of considerable interest and importance; it is at variance only with the

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* Special Report Series, No. 2, p. 10.

opinion of extremists who maintain that submission to a particular set of serological tests is the necessary criterion for deciding whether an organism is or is not a meningococcus.

From his reports on the recent epidemic, it is evident that Gordon has radically changed the opinions he expressed in 1907 as to the value of serological reactions. He now attaches high importance to these tests, and has used them as a basis for the subdivision of meningococci into "types." His reports for 1915 have been reviewed in the Medical Research Committee's Report, which expresses (pp. 59-60) the following conclusions as to the value of his serological work:—

> The "types" defined by Major Gordon by means of the agglutinin absorption test were all from the meninges and had caused epidemic cerebro-spinal fever; that is to say, they are the "epidemic races" which were mainly concerned in the outbreak in England in 1914-15. But when Gordon applied his test to pharyngeal strains, he found that only a portion of them were to be included in his types; it is possible that the residue were non-epidemic and less harmful races.

In pursuit of this last remark, the report develops a theory that meningococci may be divisible into "epidemic" and "domestic" strains. It says:—

> We may conceive this organism [the meningococcus] to be essentially a saprophyte, though with potentialities of parasitism, divided up, as most bacterial species probably are, into a number, perhaps a large number, of races distinguished by their immunological reactions. At ordinary times, when cerebro-spinal fever is not epidemic, the saprophytic spread of these races is attended only by the development here and there of sporadic cases of declared disease in the most susceptible elements of the population—the posterior basic meningitis of infants. But from time to time, and hitherto very rarely in this country, individual races attain a greater virulence and their saprophytic spread is attended not only by a larger number of cases of meningitis, but by the attack of young adults, who in ordinary circumstances are immune. Such epidemic strains may be introduced into a community and lead to an outbreak of cerebro-spinal fever: there seems some ground for the belief that at least one out of the three principal strains concerned in last year's epidemic was introduced by the Canadian troops. In any given epidemic there will occur a saprophytic spread of the epidemic strains side by side with the domestic and relatively harmless strains indigenous to the locality, so that there are carriers of either, indistinguishable except by serological means. Major Gordon suggests that only those carriers need be isolated who bear epidemic strains.
>
> This conception of epidemic cerebro-spinal fever, already we believe held by many epidemiologists, must at present be regarded as a working hypothesis only.

In short, the view of the Medical Research Committee's Report is that serological differences may be correlated with differences of virulence and may therefore be of importance in distinguishing highly dangerous from less dangerous nasopharyngeal strains. This suggestion is interesting, and, if serologically "epidemic" strains were rare except amongst direct contacts, isolation based on the segregation of "epidemic" carriers and release of "domestic" carriers might sometimes be feasible and possibly useful. But the fact is that so-called "epidemic" strains are not rare; they are common even in the non-contact population, amongst which they seldom give rise to cerebro-spinal fever. So it is difficult to see that they are really much more dangerous than the "domestics."

This view of the Medical Research Committee appears, however, to differ very considerably from Gordon's. In his later

report (1917) Gordon insists that naso-pharyngeal strains which cannot be identified serologically by means of one or other of his four monovalent sera, prepared from his four "types" of cerebro-spinal meningococci, are not to be regarded as meningococci, though they conform to the cultural and fermentation tests for the meningococcus. He terms them "non-meningococci" or "pseudo-meningococci." He thus disagrees with the opinion of the Medical Research Committee that the meningococcus can be identified by cultural tests alone, and ignores their suggestion that strains not conforming to his serological tests are merely less important varieties of that organism, because less directly associated with outbreaks of cerebro-spinal fever in its epidemic form.

Not only does he ignore this very conciliatory suggestion, evidently expressed as an appreciation of his work, but he seems definitely to repudiate it. He firmly takes his stand on the dictum that cocci not responding to his serological tests are not meningococci. By so doing, I think he places himself in serious difficulties. If, whilst rejecting the compromise suggested by the Medical Research Committee, he had taken his stand on the claim that a coccus cannot be authenticated as a meningococcus unless it agglutinates with a serum prepared from a cerebro-spinal strain, his case would have been difficult but at least it would have been arguable. But one cannot argue over a merely personal dictum which, expressed as a syllogism, would run: all meningococci must agglutinate with a serum prepared from a cerebro-spinal strain; certain naso-pharyngeal cocci do not agglutinate with Gordon's sera prepared from cerebro-spinal strains; therefore they are not meningococci. One can only remark that the conclusion is invalid.

There is one more aspect in which it is interesting to compare the Board's results with those obtained by investigators working for the military authorities. From the beginning of 1915 onwards, the Board's pathologists have consistently found that the percentage of meningococcus carriers even amongst the general (non-contact) population is notably high. Until recently, the Army investigators have not been able to corroborate this, a circumstance which I think is readily explained by the remarks from the Medical Research Committee's Report quoted at the beginning of this appendix. The Committee states that the investigators complained of the unsatisfactory results of the methods employed for detecting the meningococcus in the naso-pharynx, and adds that "the work is tedious and beset with pitfalls, while its results were often found ambiguous." Last year, however, these reasons for dissatisfaction were evidently removed, and the investigators for the Army proceeded to find high percentages of carriers, which are quite in accordance with the previous findings of the Board. The fact that a high carrier rate had been found since the beginning of 1915 suffices to disprove the hypothesis that these later results are explicable by increase in the carrier rate.

III. Second Report on the Identification of the Meningococcus in the Naso-Pharynx, with special reference to Serological Reactions; by Fred. Griffith, M.B.

TABLE OF CONTENTS.

INTRODUCTION.

In the course of an inquiry initiated at the beginning of March, 1915, into the distribution of the meningococcus among the general population, Dr. Eastwood and I had found a considerable percentage of gram-negative cocci, indistinguishable by full cultural tests from spinal meningococci, in the naso-pharynx of out-patients attending at St. Bartholomew's Hospital. These non-contact naso-pharyngeal strains were subjected by me to serological tests; and in a preliminary report,* issued in May, 1916, it was stated that they could not be excluded from the meningococcus species on the results of the agglutination reactions. The

* Report on the Identification of the Meningococcus in the Naso-Pharynx: Reports to the Local Government Board (New Series, No. 110).

conclusion arrived at was, in effect, that cultural and fermentation tests were sufficient for the identification of the meningococcus in the naso-pharynx. Questions of differentiation by serological methods between strains of meningococci, whether spinal or naso-pharyngeal in origin, were raised, but no final decision was made.

To summarise briefly the main features of the previous report, the evidence obtained indicated that differences in antigenic capacity afforded a basis for the division of meningococci into two fairly well defined groups. Moreover, this serological grouping was correlated with differences in fermentative activity in the presence of maltose and glucose. As an explanatory hypothesis I suggested that differences in agglutinin production and fermentative activity are attributable to the complexity of the meningococcus antigen, which contains two components. These give rise in the animal body to two groups of agglutinins, and the differentiation into two fairly distinct serological races is due to the fact that the majority of meningococcus strains contain these components in unequal proportions, one being markedly in excess of the other. Within each group differences are to be found because the dominant type of antigen is liable to slight variations in structure; and sometimes there is no clear distinction between the one group and the other, because in a minority of strains there is no marked preponderance of the one antigen component over the other.

The work has been continued in the hope that further light may be thrown upon this differentiation of meningococci into serological races, with particular reference to the biological relationship between cerebro-spinal strains and those naso-pharyngeal strains which have been found to be of common occurrence amongst persons not associated with cases of cerebro-spinal fever. The pharyngeal strains investigated are 89 in number, including three strains of gram-negative cocci which were distinguishable from meningococci by their pigment formation, and were used as controls. Of the 86 strains, all culturally identical with meningococci, 28 were studied in my previous report, and have been submitted to further investigation. The new strains, like those previously reported upon, have all been obtained from persons not known to have been associated in any way with cases of meningitis. The cerebro-spinal strains investigated are 66 in number, including 32 which were not mentioned in my last report.

In connection with the epidemic prevalence of cerebro-spinal fever, which occurred from February to May, 1915, and during approximately the same period but with a lower incidence in 1916, it may be of interest to record the periods in which the strains of meningococci were obtained. The spinal strains were derived from cases of meningitis occurring during the following periods: Cases 1-39, from March 23, 1915, to December 23, 1915; 40-66, from January 3, 1916, to September 14, 1916. The pharyngeal strains were obtained in three series from the outpatients at St. Bartholomew's Hospital; 1-46, from March 29, 1915, to July 22, 1915; 47-56, from January 10, 1916, to January 24, 1916; 57-89, from April 6, 1916, to June 5, 1916.

I wish to express my indebtedness to Dr. Eastwood for generous help in the preparation of this report, and to Dr. Scott for much helpful criticism.

Methods.

The usual methods of performing the macroscopic agglutination test described in my previous report have with some slight exceptions been adhered to. At first the suspensions used contained 4 mg. of moist cocci per c.c., but latterly suspensions of only 2 mg. per c.c. were preferred, as giving a sharper end-point.

All agglutinating sera were monovalent, and were prepared by inoculating rabbits intravenously with living cultures grown on glucose agar. Living culture taken from the medium immediately before inoculation appears to be less toxic than killed culture. The final readings of the agglutination tests were made after 24 hours in the incubator at 55 degrees C., and a further 12 hours in the ice-chest or at room temperature. For absorption tests the agglutinating sera have been used in dilutions of 1 : 50 and 1 : 100. Heated and unheated cultures have been used, both in small and in large amounts. Information on these points is given in the heading of each table.

Cerebro-spinal and Naso-pharyngeal Meningococci compared in respect of :—(1) Agglutinability.

The agglutination tests upon spinal and pharyngeal meningococci with monovalent meningococcus sera have been summarised for the purposes of comparison in Tables I and II. So far as possible the experimental conditions in the two series have been identical.

In interpreting the results of agglutination tests upon meningococci it is necessary to bear in mind the varying agglutinability of different suspensions of the same strain prepared at different times. The causes underlying this variability are not always the same, and in some instances there is evidence of an alteration, occurring during subcultivation, in the constitution of the culture from which the suspension was prepared. In other cases the failure to form clumps appears to be a temporary phase, and it is therefore impossible to assert, when the result with a particular serum is negative, that the response to that serum will invariably be the same. With the object of eliminating disturbing factors, so far as possible, many of the agglutination tests from which my tables have been prepared have been frequently repeated; where the results have differed, the highest titre has been recorded.

As regards the method adopted, the culture suspensions, after being heated to 65° C. for $\frac{1}{2}$ to 1 hour, were diluted with 0·5 per cent. carbolic salt solution to a uniform density of 2 mg. per c.c. and were stored for several weeks before being used. The end-point chosen for comparative work is that dilution of serum in which the cocci have deposited, leaving the supernatant fluid clear or with very slight opalescence when examined in a good oblique light.

The figures in the tables represent the numerical value of the highest dilution in which the end point was reached, the maximum recorded in the table being 1: 1000. The titres of the six sera used were approximately equal, ranging from 1 : 800 to 1:1600 with different suspensions of each homologous strain. The symbols $\pm$ and — indicate respectively an incomplete and a negative result at 1:100; tr. indicates slight agglutination, the supernatant fluid remaining turbid.

The six monovalent agglutinating sera were prepared with strains which had been grown from the cerebro-spinal fluid of cases of meningitis occurring during the 1915 period of prevalence of cerebro-spinal fever: they were chosen because they agglutinated between them most of the spinal strains. With the exception of M34 none of the heated suspensions of the spinal or pharyngeal strains was agglutinated in 1:50 by normal rabbit serum.

Table I summarises the results with the spinal strains; the first 34 strains are arranged as in the previous report to show the grouping; the remaining strains are in the serial order in which they were obtained.

On examination of Table I it will be seen that if the sera M 18 and M 24, which I call Group II, and M 10 and M 43, which I call Group I, are taken as standards, the spinal strains can be divided into two moderately well defined groups, excluding certain strains which may be classed as intermediate or indeterminate. Amongst the strains which appear to be definitely grouped are two, M 32 and M 33, which are agglutinated sufficiently well by M 18 and M 24 sera to be considered as belonging to the same group as the strains M 18 and M 24, and to a different group from M 10 and M 43. But the sera produced with M 32 and M 33 invalidate the grouping, since they on the one hand agglutinate strains not affected by M 18 and M 24 sera, and on the other hand leave unaffected strains which these same two sera agglutinated.

It is clear, therefore, that the strains M 18, M 24, M 32 and M 33, which appear to belong to the same group, though closely inter-related as regards agglutinin production and agglutinability, are not identical with each other in either respect.

TABLE I.

Agglutination tests on 66 spinal (M) strains with four Group II sera and two Group I sera, prepared with spinal strains.

M Strain.	Group I sera.		Group II sera.				M Strain.	Group I sera.		Group II sera.			
	Serum M 10.	Serum M 43.	Serum M 18.	Serum M 24.	Serum M 32.	Serum M 33.		Serum M 10.	Serum M 43.	Serum M 18.	Serum M 24.	Serum M 32.	Serum M 33.
1	1,000	1,000	—	±	±	±	35	—	—	200	100	±	100
2	1,000	1,000	—	tr.	tr.	±	36	800	200	±	200	±	200
3	400	200	—	—	±	100	37	—	—	400	800	400	400
4	1,000	1,000	—	±	±	100	38	tr.	—	800	400	800	100
5	1.000	800	±	±	±	±	39	—	—	800	400	200	200
6		1,000	±	100	200	100	40	1,000	1,000	tr.	tr.	±	200
7	1,000	400	—	∓	±	100	41	1,000	200	—	400	±	400
8	1,000	1,000	—	200	tr.	100	42	—	—	400	200	100	100
9	1,000	1,000	—	±	tr.	100	43	800	1,000	±	—	±	100
10	1,060	1,000	—	—	tr.	100	44	—	—	1,000	200	800	200
11	800	100	—	200	±	400	45	tr.	—	1,000	1,000	200	400
12	800	1,000	200	100	tr.	±	46	—	—	tr.	200	±	±
13	800	1,000	±	±	±	100	47	100	—	1,000	200	200	200
14	400	100	±	±	±	100	48	1,000	200	—	±	200	400
15	800	±	—	100	∓	200	49	—	—	1,000	200	400	200
16	100	100	400	±	±	200	50	200	1,000	100		100	400
17	400	1,000	400	±	tr.	200	51	200	100	±	200	100	400
18	—	—	1,000	400	400	400	52	1,000	1,000	±	—	200	±
19	100	±	1,000	400	±	±	53	200	400	—	—	—	±
20	±	—	400	200	±	400	54	tr.	—	1,000	400	400	400
21	400	100	1,000	800	100	400	55	—	—	200	200	±	100
22	—	—	800	400	100	400	56	200	1,000	200	±	±	±
23	—	—	400	800	400	400	57	tr.	tr.	1,000	1,000	200	200
24	—	—	1,000	1,000	200	400	58	±	—	1,000	100	100	±
25	200	±	1,000	400	100	±	59	200	1,000	200	±	±	200
26	—	—	1,000	400	800	200	60		—	400		±	±
27	—	±	1,000	400	200	400	61	—	—	1,000	400	200	400
28	—	—	1,000	200	200	200	62	—	—	±	200	±	400
29	tr.	—	400	200	100	200	63	—		±	±	±	100
30	—	—	800	400	100	400	64	±		1,000	400	100	1,000
31	—	±	tr.	400	1,000	800	65	400	100	±	±	—	100
32	—	—	200	400	1,000	200	66	—	—	400	±	100	100
33	—	—	800	400	200	800							
34	1,000	200	1,000	1,000	400	400							

The symbols ±, — and tr. refer to reactions at 1 : 100.
± = well marked but incomplete agglutination.
— = no agglutination.
tr. = trace of agglutination.

TABLE II.

*Agglutination tests on *86 naso-pharyngeal (NP) strains with the same spinal sera as in Table I.*

NP. Strain.	Group I sera. Serum M 10.	Group I sera. Serum M 43.	Group II sera. Serum M 18.	Group II sera. Serum M 24.	Group II sera. Serum M 32.	Group II sera. Serum M 33.	NP. Strain.	Group I sera. Serum M 10.	Group I sera. Serum M 43.	Group II sera. Serum M 18.	Group II sera. Serum M 24.	Group II sera. Serum M 32.	Group II sera. Serum M 33.
1	800	200	—	—	±	tr.	47	tr.	—	200	400	tr.	±
2	400	200	—	200	200	400	48	—		1,000	200	200	200
3	100	400	tr.	tr.	400	200	49	tr.	100	—	400	±	200
4	400	100	—	800	400	400	50	±	—	1,000	200	±	400
5	±	200	100	400	400	400	51	—	—	tr.	800	400	1,000
6	—	—	400	200	200	200	52	—	±	tr.	200	—	200
7	—	—	200	200	tr.	100	53	1,000	1,000	—	tr.	tr.	200
8	—	—	400	400	100	200	54	±	±	1,000	800	200	200
9	—	—	400	200	1,000	400	55	±	±	—	400	400	400
10	—	—	400	200	100	200	56	tr.	tr.	±	200	200	200
11	—	—	—	—	tr.	200	57	tr.	±	—	200	±	100
12	—	—	—	400	tr.	±	58	—	—	400	100	100	100
13	—	—	±	100	400	200	59	—	—	800	200	400	200
14	—	400	—	800	—	200	60	—	—	—	200	100	200
15	—	—	±	±	100	200	61	±	—	400	200	±	200
16	—	±	400	400	100	800	62	—	—	—	200	±	1,000
17	200	200	±	400	400	800	63	—	—	—	100	±	100
18	±	—	tr.	200	800	800	64	±	—	400	100	tr.	100
19	—	200	—	100	—	±	65	±	1,000	800	200	±	100
20	—	—	—	—	—	±	66		—	1,000		800	400
21	—	±	—	±	—	100	67	—	±	200	100	±	100
22	—	—	200	200	400		68	tr.	—	—	400	200	200
23	—	100	tr.	400	±	400	69	tr.	—	∓	100	—	100
24	—	±	—	200	—	100	70	±	tr.	—	±	—	100
25	—	—	—	200	±	200	71	±	200	100	±	—	—
26	±	±	200	400	400	400	72	—	—	1,000	200	400	200
27	—	±	—	400	200	200	73	—	—	1,000	200	200	400
28	tr.	—	1,000	100	—	±	74	—	—	—	200	200	±
31	tr.	—	200	400	±	400	75	—	—	1,000	400	400	200
33	tr.	—	—	±	—	—	76	—	tr.	—	400	200	200
34	—	—	200	400	1,000	200	77	tr.	100	—	200	100	200
35	±	—	1,000	400	400	200	78	—	—	1,000	200	±	200
36	—	tr.	400	200	100	400	79	—	—	—	100	—	±
37	—	—	800	400	±	200	80	—	—	1,000	200	100	200
38	—	—	1,000	1,000	400	200	81	—	—	100	200	800	±
39	±	100	100	200	±	400	82	—	—	—	—	—	±
40	±	100	1,000	400	±	200	83	—	100	±	400	200	400
41	400	±	±	400	100	100	84	—	tr.	1,000	400	200	200
42	—	—	—	100	±	400	85	±	—	400	100	200	200
43	±	±	400	400	100	400	86	—	tr.	—	—	—	±
44	—	—	±	100	—	±	87	—	—	1,000	400	200	200
45	—	tr.	400	200	400	200	88		±	400	200	400	200
46	—	—	800	±	tr.	—	89	—	100	—	200	±	400

* Three pigmented strains 29, 30 and 32 used as controls are omitted from this table; they gave no agglutination.

The symbols have the same meaning as in the preceding table.

A further obstacle to the division of meningococci into two or more well defined groups is the fact that there are strains either relatively inagglutinable towards the group sera or agglutinated equally by sera of both groups.

To sum up the position as regards agglutinability, the spinal meningococci can be separated into two main groups by means of selected sera, but such division cannot be strictly maintained if sera made from unselected strains are used, since strains grouped in a particular fashion by one set of sera do not necessarily behave uniformly in relation to a different set of sera. This division into two groups must therefore be admitted to be imperfect and somewhat artificial, since it depends on the arbitrary selection of particular sera and the exclusion of other sera. Nevertheless, when these limitations are recognised, a rough division into two main groups is of great importance to a correct appreciation of the inter-relationship between strains of meningococci.

The question of grouping strains may be looked at from another point of view which indicates the principle employed in selection. Every serum which exercises a definite selective action upon strains belonging to one or other of the two groups may be considered to contain agglutinins with special affinities for that particular group. Reviewing the method of classification used in my previous report, one finds that M1 to M17 were classed as Group I strains and M18 to M34 as Group II strains, on the ground of simple agglutinability with particular sera. From the above considerations, this may be more correctly expressed by saying that this grouping is based on a selective response to particular agglutinins, viz., a response to the predominant agglutinins produced by the antigens of M10 and M43 in the case of Group I and a response to the agglutinins produced by the antigens of M 18, M 24, M 32, M 33 in the case of Group II. In other words, agglutinogenic capacity would be a more scientifically accurate basis for classification, as it would provide identification of the antigens producing the special agglutinins. Agglutinability is too variable a property to be strictly reliable. It is, however, a useful guide to identification inasmuch as it effects a rough demarcation of strains into two groups. I have therefore continued to refer to particular strains as belonging to Group I or Group II when there is sufficient evidence of the predominance of one or other of the two group antigens.

Turning now to Table II, the next step in the analysis of these tables is to compare the agglutinability of spinal and pharyngeal strains in relation to the agglutinins of the above-mentioned six sera. This table, read in conjunction with Table I, shows that although an exact serological classification of meningococci into groups cannot, as shown in the previous discussion, be made upon the results of simple agglutination tests alone, important evidence of relationship is obtained which can be correctly interpreted by subsequent investigation of agglutinogenic and absorptive capacities. It will facilitate comparison of the two series of strains in respect of agglutinability if the tables are summarised in the following way. I have taken a titre which

is sufficiently high to be regarded as of definite serological significance, and have ascertained the total number of strains in the two series attaining or surpassing this titre in respect of each serum. Since each of the six sera has a titre ranging from 1:800 to 1:1600 with different suspensions of the homologous strain, a complete agglutination result in a dilution of 1:400 may be taken to constitute important evidence of relationship. The results are summarised in the following table, which gives under the heading of each serum the percentage of spinal and pharyngeal strains agglutinated completely in a dilution of 1:400 or over.

TABLE III.

Summary of Tables I and II, giving the percentages of spinal and pharyngeal strains agglutinated to 1:400 by each serum.

Total strains.	M 18 Serum.	M 24 Serum.	M 32 Serum.	M 33 Serum.	M 10 Serum.	M 43 Serum.
66 spinal	47 %	35 %	17 %	33 %	41 %	30 %
86 pharyngeal ...	37 %	34 %	24 %	25 %	6 %	5 %

Comparing one series with the other as regards the total strains agglutinated by one or more of the six sera, it is found that 94 per cent. of the 66 spinal strains were agglutinated to 1:400 or over, and 72 per cent. of the 86 pharyngeal strains reacted to a similar extent.

It will be seen from Table III that the relative proportions of spinal and pharyngeal strains agglutinated up to 1:400 by the Group II sera do not differ materially. The agglutinins of M 18 and M 33 sera find among the spinal strains more combining affinities than among the pharyngeal, but the reverse is the case with M 32 serum, and M 24 serum influences spinal and pharyngeal strains in equal numbers.

In striking contrast to the above, the Group I agglutinins contained in M 10 and M 43 sera find related antigens 6—7 times more frequently among the spinal than among the pharyngeal strains.

Two alternative explanations may be suggested to account for this difference in reaction between naso-pharyngeal and cerebrospinal strains in the presence of a Group I serum:

(1) Group I antigen is a rare component of the pharyngeal meningococcus of the non-contact, while it is represented as commonly as Group II antigen in strains of spinal meningococci. Thus, if the proportions found in this investigation reflect the general distribution of the two groups, both in meninges and naso-pharynx, it may be inferred that the meningococcus of Group I more frequently invades the meninges from the nasopharynx than the meningococcus of Group II.

(2) The antigen of Group I in the pharyngeal meningococcus, though not revealed by the two Group I sera used, might be shown to have combining affinities for agglutinins produced by other spinal strains containing Group I antigen.

Some evidence in regard to this second hypothesis is furnished by agglutination tests with sera of Group I prepared with M 15, M 16, and M 17.

M 17 serum, titre 1:800 to 1:1600, was found to agglutinate completely NP4 and NP5 up to 1:800; NP 3, 17, 53, 65, 70, 71, up to 1:400; NP 67 and 86 up to 1:200.

M 15 serum, titre 1:400, agglutinated completely in 1:100, NP 19, 21, 24, 44, 52, 56, 60, and 70.

M 16 serum, titre 1:800 to 1:1600, agglutinated NP 2 to 1:800, NP 70 and 71 to 1:400, and NP 74 to 1:200.

A further point brought out by comparison of Tables I and II is that the number of spinal strains not agglutinated by any of the six spinal sera up to 1:400 was 4 (6 per cent.), while the corresponding number of pharyngeal strains was 24 (28 per cent.). This clearly constitutes a distinction of some importance between the spinal and the pharyngeal strains. But failure to attain an arbitrary standard of agglutination on the part of certain pharyngeal strains is no proof that they are specifically different from meningococci of proved pathogenicity, since on the same grounds a proportion of the latter would also be excluded from the meningococcus species.

It is possible that the spinal strains which were agglutinated weakly by the selected spinal sera have other serological features in common with the similarly reacting pharyngeal strains. The relationship of these strains to each other and to other spinal strains will be considered later in the light of the more precise knowledge of the combining qualities of antigens which can be gained from the production of agglutinating sera and from agglutinin absorption experiments.

The general result of the comparison of naso-pharyngeal strains with cerebro-spinal in respect of agglutinability may be summed up as follows:

(1) The agglutinins of Group II in the sera produced by M 18, M 24, M 32, and M 33 combine in almost equal proportions with spinal and pharyngeal strains.

In contrast, the agglutinins of Group I in the sera produced by M 10 and M 43 have more combining affinities with spinal strains than with pharyngeal.

(2) Strains which have little capacity for combining with the agglutinins of either Group I or Group II in the six spinal sera are found between four and five times more often in the pharyngeal series of meningococci than in the spinal.

(2) Agglutinogenic Capacity.

In the preceding section, which deals with simple agglutination tests, under identical conditions, on cerebro-spinal and naso-pharyngeal strains, six monovalent agglutinating sera prepared with spinal strains were employed. Two of these sera, M10 and M 43, were found to exercise a selective action upon one group of strains, while the two sera, M18 and M24, influenced a second group which were not agglutinated by the first two sera. The strains M 10 and M 43 evidently possess antigenic capacities which differ from those of M 18 and M 24. The agglutinins which each of these four strains produces are capable of combining with similar

antigens in other strains, but the reaction of agglutination resulting from such combination is not necessarily evidence that the antigens concerned are equally represented in the strain agglutinated and in the strain producing the agglutinin. For example, the strains M32 and M33 are agglutinated by the Group II sera M18 and M24, but the sera which they produce are by no means identical either with the latter or with each other in their selective action upon the whole series of spinal meningococci (see Tables I and II). In my previous report a more marked illustration was given of the absence of correspondence between agglutinability and agglutinogenic capacity. Two strains, NP 10 and NP 11, were both agglutinated by the same Group II sera, and were almost identical in agglutinability. While the serum produced with NP 10 agglutinated exclusively the spinal strains of Group II, NP 11 serum agglutinated mainly the Group I spinal strains.

The above evidence indicates that agglutinogenic capacity sometimes brings to light affinities not demonstrable by simple agglutination between the antigens possessed by different strains. Further observations have been made with a view to ascertaining whether the complete antigenic capacities of the various strains are revealed by the tests of agglutinability with the six selected sera, the results of which are summarised in the first two tables. Certain pharyngeal and spinal strains were selected for the preparation of agglutinating sera. The results of tests with these sera on spinal and pharyngeal strains are set out in Tables IV, V, and VI. There is a difference in technique which must be noted in comparing these with the preceding tables. In the preceding tables the strength of the suspensions was 2 mg. per c.c., but in these it was 4 mg. per c.c. throughout, and this alteration approximately doubles the apparent agglutinating titre.

TABLE IV.

Agglutination tests on an unselected series of 16 naso-pharyngeal strains with a Group I spinal serum and a Group II spinal serum and with sera made from 8 naso-pharyngeal strains.

Strain.	M 23 Serum	M 9 Serum	NP 10 Serum	NP 11 Serum	NP 36 Serum	NP 39 Serum	NP 40 Serum	NP 41 Serum	NP 43 Serum	NP 44 Serum
NP 31	—	—	—	200	400	±	±	±	±	400
NP 32*	—	—	—	—	—	—	—	—	—	—
NP 33	100	±	±	100	200	—	—	100	—	±
NP 34	400	—	100	200	—	±	±	—	±	400
NP 35	200	—	200	±	—	±	—	—	—	±
NP 37	200	—	200	—	—	—	—	—	—	—
NP 38	400	—	200	100	—	±	—	—	±	100
NP 36†	200	±	100	1,000	800	100	100	100	200	200
NP 39	—	±	—	100	100	400	200	±	100	800
NP 40	—	200	—	200	±	200	400	±	200	400
NP 41	—	±	±	1,000	200	—	200	800	200	±
NP 42	—	—	—	800	200	±	—	—	100	200
NP 43	—	100	±	1,000	200	200	200	400	400	800
NP 44	—	—	±	200	—	100	100	±	200	400
NP 45	1,000	—	400	200	100	200	±	±	±	200
NP 46	—	—	—	—	—	—	—	—	—	—

* Pigmented gram-negative coccus.
† NP. 36 has been removed from its serial order to make clearer the tendency to grouping.

Analysis of Table IV.

The sixteen naso-pharyngeal strains, NP31—NP46, represent the positive findings (except NP32) from about 200 consecutive throat swabs. They form an unselected series which may be taken as an average sample of non-contact meningococci. NP32, included as a control, was a golden yellow pigmented culture of a gram-negative coccus with the fermentation reactions of the meningococcus.

Orientation tests were made with two spinal sera upon the pharyngeal suspensions, which were the same throughout, and the results are given in the second and third columns. M9 serum contains agglutinins of Group I, and M23 serum agglutinins of Group II. It will be seen from the table that seven of the pharyngeal strains are agglutinated by the Group II serum and two by the Group I, the remainder not responding to the action of either serum.

In the light of these results, certain of the pharyngeal strains were selected for the production of sera, preference being given to those which were not agglutinated to any marked degree by either of these two spinal sera.* The two sera made with NP 10 and NP 11, referred to above, were included for comparison.

The results of these tests, as shown in the table, are that, with the exception of NP10 serum, none of the pharyngeal sera agglutinates the same collection of pharyngeal strains as the two standard spinal sera. NP10 has almost the same selective action as M23 serum (Group II). The agglutination results with the other pharyngeal sera appear at first sight irregular, but present the following features of significance:—

(1) They generally fail to agglutinate those pharyngeal strains which were agglutinated by the standard Group II serum (M23).
(2) They are fairly consistent in agglutinating the strains not affected by M23 serum.
(3) They agglutinate NP40 and NP43, the only two strains in this series affected by the standard Group I serum (M9).
(4) They therefore differ from Group II, as represented by M23 antigen, and appear to resemble Group I, as represented by M9 antigen.

In order to throw further light on the characters of these pharyngeal strains I have tested the sera prepared with them upon two series of spinal strains representative of Group I (Table V) and Group II (Table VI).

* Later tests, however, showed that several were agglutinated by other spinal sera of Group II, M 18 and M 24. (*See* Table II.)

TABLE V.

Agglutination tests on spinal strains of Group I with sera prepared from 6 naso-pharyngeal strains, and from two spinal strains of relatively feeble absorptive capacity.

Strain.	M 16 Serum.	M 46 Serum.	NP 39 Serum.	NP 40 Serum.	NP 41 Serum.	NP 43 Serum.	NP 44 Serum.	NP 36 Serum.
M 1	±	800	400	200	200	200	400	200
M 2	200	200	200	100	200	±	200	200
M 3	100	200	200	200	200	100	400	200
M 4	±	200	400	200	200	200	400	200
M 5	±	200	400	200	200	200	200	200
M 7	±	200	200	200	200	100	100	200
M 8	100	200	400	200	200	200	400	±
M 9	200	200	200	200	200	200	400	200
M 10	±	200	100	200	200	100	200	200
M 11	200	200	200	400	400	100	400	200
M 12	±	—	200	400	100	200	200	200
M 13	100	—	200	100	±	±	400	200
M 14	±	100	100	100	400	100	200	200
M 15	±	—	±	200	800	100	200	200
M 16	*±	100	±	±	400	100	200	100
M 17	±	±	200	200	100	100	400	400
M 36	400	±	100	200	400	100	400	100
M 40	±	±	200	400	100	200	400	400
M 41	200	100	200	200	400	200	400	200
M 43	200	100	100	100	200	±	400	200
M 46	±	100				200	±	±

* Agglutination marked but incomplete up to 1 : 400.

TABLE VI.

Agglutination tests on spinal strains of Group II to compare with Table V.

Strain.	M 16 Serum.	M 46 Serum.	NP 39 Serum.	NP 40 Serum.	NP 41 Serum.	NP 43 Serum.	NP 44 Serum.	NP 36 Serum.
M 18	±	±	200	±	±	±	200	—
M 19	±	—	±	—	±	±	±	—
M 20	—	—	±	—	—	±	±	—
M 21	800	400	200	—	400	±	200	100
M 22	—	±	200	100	100	200	200	100
M 23	—	±	±	100	±	—	100	±
M 24	±	±	±	±	—	—	±	—
M 25	±	100	±	—	±	100	±	±
M 26	—	±	100	100	±	±	100	100
M 27	±	—	±	—	±	±	100	±
M 28	±	—	—	—	—	—	±	—
M 29	±	±	±	—	±	±	200	—
M 30	—	—	±	100	—	—	±	—
M 31	±	—	±	—	±	—	±	—
M 32	±	—	—	±	—	—	±	—
M 33	100	±	±	±	—		200	±
M 34	±	±			200		100	±
M 35	—	±	±	—	±	—	±	—
M 37	±	±	±	±	±	±	200	
M 38	—	±	±	100	±	—	100	—
M 39	—	—	100	—	—	±	100	±
M 42	±	—	±	—	—	—	±	±
M 44	±	±	±	±		100	±	—
M 45	100	100	100	±	±	100	200	±

These tables (V and VI) show the following results with the sera prepared from the 6 strains NP 36-44:—

(*a*) Good agglutination with cerebro-spinal meningococci, though usually short of full titre.
(*b*) More uniform influence on Group I strains.
(*c*) Agglutination of some of the Group II strains to half full titre.

It will be observed that: (*a*) shows the relationship of these strains to cerebro-spinal meningococci; (*b*) confirms their antigenic relationship to Group I, already suggested by M9 serum above; (*c*) shows their relationship to Group II antigens, which was not brought out by M23 serum, but had been indicated (Table II, p. 57) by agglutination tests with other Group II sera (M18, etc.).

Tests of agglutinogenic capacity therefore show that some of these naso-pharyngeal strains, *e.g.*, NP 44, possess both Group I and Group II antigens. As a parallel to this interesting fact, I call attention to the following details of tests with three spinal sera, two of which are included in Tables V and VI. In agglutinogenic capacity the strains M 16, M 46 and M 55, used to produce the sera, appear to have features in common with the above-mentioned pharyngeal strains.

M16 was agglutinated to 1 : 100 with M8 serum (Group I), and at first absorbed the homologous agglutinin well, but not completely. After prolonged subculture it retained its slight agglutinability towards Group I sera, and was also agglutinated by certain Group II sera, but exhibited no absorptive capacity for sera of either group. After repeated inoculations of living culture into a rabbit, a serum was obtained which agglutinated the homologous strain incompletely in from 1 : 100 to 1 : 400. Later the homologous strain became much more agglutinable, giving a complete reaction to the same serum in 1 : 800 to 1 : 1600. The results of the agglutination tests show it to be an indifferent serum of low multivalency, related slightly to both groups. M46 was obtained from basal meningitis in an infant, and in its relative inagglutinability resembled certain pharyngeal strains previously mentioned. Although M46 was agglutinated a little by M24 serum (Group II) and not by the two Group I sera, its agglutinogenic capacity reveals a closer relationship to the spinal strains agglutinated by Group I sera.

M55 was another cerebro-spinal strain which, like the above two, could not be identified with either of the two groups which form the majority; it was obtained from a case of post-basal meningitis in a child aged 8 months. It was agglutinated slightly by Group II sera. A serum was prepared from it and tests were made upon the spinal strains. The agglutination results, which are not given in the table, are as follows. The homologous strain was agglutinated completely in a dilution of 1 : 800, and M 31 to 1 : 400; none of the other spinal strains tested, whether of Group I or Group II, was agglutinated higher than 1 : 100. Brief reference may be made to the reactions of two of the remaining pharyngeal strains.

NP31 had poor antigenic qualities and produced a serum with

no higher titre than 1:200 for the homologous culture. This serum agglutinated only two of the spinal strains of Group II up to 1:200 and none of the Group I strains.

NP46 culture was tested with a large number of spinal and pharyngeal sera, and seemed to have no combining affinities until it was tried with M18 serum (titre about 1:1600) which agglutinated it completely up to 1:800. Its agglutinogenic capacity was not tested.

Summary of Agglutinogenic tests.

The following inferences are to be drawn from the above results.

(1) Agglutinability does not invariably correspond with agglutinogenic capacity.

(2) The production of an agglutinating serum, *i.e.*, the demonstration of agglutinogenic capacity, confirms the evidence of specific relationship between spinal and pharyngeal strains based on the agglutination tests with standard meningococcus sera.

(3) In both the cerebro-spinal and the naso-pharyngeal series, strains occur in which there is no marked predominance of one group antigen over the other.

(4) Compared with the standard spinal strains these pharyngeal strains with the characters described above may be summed up as being less well defined in relation to the two main groups both in agglutinability and in agglutinogenic capacity. In this respect there is a close analogy between them and the anomalous spinal strains, M16, M46 and M55.

(3) Agglutinin Absorption.

The preceding experiments on agglutinability and agglutinogenic capacity have shown that cerebro-spinal and naso-pharyngeal meningococci possess antigenic substances common to both classes, and that the serological differences which can be demonstrated between spinal and pharyngeal strains are not greater either qualitatively or quantitatively than the differences between individual spinal strains.

It is recognised that an antigen may be the common constituent of related organisms which have specifically distinct pathogenic properties, and that agglutinability in itself is not conclusive evidence of identity. On the same grounds, but to a less degree, the evidence supplied by agglutinogenic capacity may not always be conclusive. A strain of gonococci, for example, may produce a serum which agglutinates some strains of meningococci. The final criterion of serological identity is the absorption of agglutinin. This test provides more precise information as to the combination of agglutinin and antigen than the simple agglutination test alone, and it defines more clearly than the agglutinogenic test the degree of relationship between the antigens of different strains.

The absorption tests have been carried out on the following plan. In the first place the relationship between the different spinal strains has been worked out, and several varieties of antigens and agglutinins have been defined in each of the two main

groups. The results have then been applied to the identification of such combining affinities in the naso-pharyngeal strains and sera as are similar to the affinities exhibited by the antigens and agglutinins of the spinal strains.

A uniform method of absorption has not been adopted: the quantities and condition, *i.e.*, heated or unheated, of the culture employed for absorption, and the dilutions of the absorbed serum have been varied and will be noted under each series of experiments. The experiments have been arranged in two series following the rough classification into two groups indicated by agglutination, on the assumption that there are two primary antigenic substances in the meningococcus and that the agglutinins produced by one substance or its variations cannot combine with the other.

Agglutinin absorption with spinal strains of Group I.

The method adopted was to bring together equal parts of a 1 in 25 dilution of serum and a heated suspension containing 4 mg. of cocci per cubic centimetre. After absorption, which was generally allowed to take place at room temperature, the serum was titrated and tested in dilutions of 1 in 100 up to the full titre on the strain with which the serum had been prepared (referred to as homologous). Specific absorption of agglutinin was considered to have taken place when the agglutinating power of the absorbed serum was definitely reduced for the homologous strain. The standard of reduction was that produced by the homologous strain itself under the same conditions.

The sera used in this series were those which contained mainly the agglutinins of Group I. For absorption, 21 strains all agglutinated by these sera were selected from the first 46 spinal strains. To these M 46 was added, because, though not agglutinated by these sera, it was shown to produce agglutinins for Group I strains. The number of strains used was limited in the first instance to these 22, in order that the test with each serum might be completed on a single occasion, and that the conditions of each experiment should be identical for all the strains concerned.

The absorption tables are arranged as follows. In the first column are the strains used for absorbing the serum. The succeeding columns show the results of testing, in the dilutions given at the head of each column, the agglutinating action of the serum upon a test suspension, generally that of the strain producing the serum. The first test is with the unabsorbed serum; the rest show how this initial titre is affected by the treatment with each of the strains used for absorbing. In Table VII an absorption experiment with M 10 serum is given in full. It consists of two parts, showing the effect of two successive additions of culture. As will be seen, certain of the 22 strains removed varying amounts of the agglutinin which acts upon M 10, while others left this agglutinin unaffected.

The result with M 6 shown in Table VII is exceptional. At the time when the culture for absorption was made this strain had lost its agglutinability and absorbing capacity, which were originally the same as the other strains in the first ten. On returning to an older subculture and retesting, the original absorbing capacity was exhibited.

TABLE VII.

M 10 serum absorbed with 22 spinal strains. Absorbed and unabsorbed serum titrated and tested upon the same suspension of the homologous strain.

Method.—First absorption: Equal parts of 1:25 dilution and suspensions containing 4 mg. of heated culture per c.c. Second absorption: Each suspension again added to the absorbed serum now in 1:50 dilution.

Absorbing Strain.	Test on M 10 After 1st absorption.				Test on M 10. After 2nd absorption.			
	200	400	800	1,600	200	400	800	1,600
*Nil ...	+	+	+	+	+	+	+	±
M 1 ...	+	+	—	—	+	+	—	—
M 2 ...	+	+	±	—	±	—	—	—
M 3 ...	+	+	+	±	—	—	—	—
M 4 ...	±	—	—	—	—	—	—	—
M 5 ...	±	—	—	—	—	—	—	—
M 6 ...	+	+	+	+	+	+	+	±
M 7 ...	+	+	—	—	tr.	—	—	—
M 8 ...	+	±	—	—	—	—	—	—
M 9 ...	+	+	tr.	—	—	—	—	—
M 10 ...	+	+	±	—	—	—	—	—
M 11 ...	+	+	+	+	+	+	+	±
M 12 ...	+	+	+	+	+	+	+	+
M 13 ...	+	+	+	+	+	+	+	±
M 14 ...	+	+	+	+	+	+	+	±
M 15 ...	+	+	+	+	+	+	+	±
M 16 ...	+	+	+	±	+	+	+	±
M 17 ...	+	+	+	+	+	+	+	±
M 36 ...	+	+	+	+	+	+	+	±
M 40 ...	+	+	+	tr.	±	—	—	—
M 41 ...	+	+	+	+	+	+	+	±
M 43 ...	+	+	tr.	—	—	—	—	—
M 46 ...	+	+	+	+	+	+	+	+

* Nil signifies that the test on M 10 suspension is with the control portion of M 10 serum treated like the others except that no culture was added.

In this and succeeding tables—

+ = complete agglutination.

± = incomplete agglutination.

— = no agglutination.

tr. = trace of agglutination.

Sera were prepared with some of the strains which absorbed and with others which failed to absorb, and have been used to test in a similar manner the absorbing capacity of the whole series of 22. The extent to which the agglutinin was removed varied with different sera, but in general the ease with which the agglutinating power of a serum with a titre of over 1:1000 was almost completely annulled by small amounts of culture was characteristic of sera of this group.

For the sake of brevity I have not reproduced in detail the tables recording the tests with the other sera, but have summarised the results. In the following scheme I have taken the 22 strains, and shown that they differ in range of absorptive

capacity (indicated by a thick horizontal line) when tested against 6 sera.

Strains used for absorption.	Sera absorbed.				
	M 1, 8, 9, 10 containing A agglutinin.	M 15 containing C agglutinin.	M 17 containing B agglutinin.	M 16.	M 46.
M 10, 40, 43	——	——	——		
(1) ... M 1—9	——	——			
(2) ... M 12, 13, 17		——	——		
(3) M 11, 14, 15, 36, 41		——			
M 16				——	
M 46					——

(1) Sub-group A. (2) Sub-group B. (3) Sub-group C.

Strains 11, 14, 15, 36, and 41 remove only the agglutinin from M 15 serum, which must therefore contain an agglutinin with a special combining affinity for a particular antigen in that group of strains. This agglutinin may be designated C.

Strains 12, 13, and 17 remove not only M 15 agglutinin, but, unlike 11-41, also M 17 agglutinin. This group must therefore contain an additional antigen with a combining affinity for a different agglutinin in M 17 serum. The latter may be designated B.

Strains 1-9 agree with 11-41 in removing C agglutinin and in failure to remove B agglutinin, but differ from both 11-41 and 12-17 in removing the agglutinin from the sera M 1, 8, 9, and 10, which were not affected by either of the two last mentioned groups of strains. These sera, M 1-10, must therefore contain an agglutinin, not present in sera M 15 or M 17, which may be designated A.

Strains 10, 40, and 43 remove both A, B, and C.

Strains 16 and 46 remove neither A, B, nor C, but only the agglutinin from their own sera. They are put in Group I because they agglutinate Group I strains better than Group II (see p. 63).

The special characters of the various Group I sera used in the above summary require some annotation.

M 1 serum had a titre of 1:1600 and was prepared after the strain had been sub-cultivated for nearly a year. A definite distinction between the strains respectively absorbing and non-absorbing was brought out by agglutination tests alone with this serum, which was not the case with the other sera of this sub-group A. Absorption was well marked, the titre being reduced from 1:1600 to less than 1:100, and the same strains which absorbed the homologous aglutinin also absorbed from M 1 serum the agglutinin which acted on M 10 and M 43.

M 8 serum had a titre of 1:800. While there was not brought out by simple agglutination the same differentiation as above between the absorbing and non-absorbing strains, the differences in absorptive capacity were well marked, not the least reduction being effected by the latter, while a large reduction was produced by the former.

M 9 serum, with a titre of 1 : 800, was not so readily absorbed as the two preceding sera. M 1 only reduced the agglutinating power from 1 : 800 to 1 in 400. Not the least reduction was effected by the non-absorbing strains.

M 17 serum, titre 1 : 800, showed a trace of reduction in the highest dilutions with the negative strains and complete absorption with the positive, excepting M 43. This strain on some occasions absorbed well and on others very little.

M 15 serum had a titre of 1 in 400 and this only as the result of prolonged immunisation of the rabbit. Absorption was almost complete with all 20 strains, excepting M 1, with which it was slight. The non-absorbing strains, M 16—M 46 and the inagglutinable strain of M 6, made not the least impression.

Absorptive capacity in relation to the quantity and physical condition of the culture used for absorption.

The question must be considered whether, since the above grouping was effected by the use of minimal quantities of absorbing culture, the differences in absorptive capacity are to any extent merely quantitative.

Further experiments have been made with the above-mentioned 22 strains upon Group I sera, to ascertain the effect of absorbing with larger amounts of culture and with unheated culture. The results are as follows, under the head of each serum:

M 1 serum.—Suspensions increased to 30 mg. per c.c. and added to equal parts of 1 : 25 serum showed practically no increased absorption with the non-absorbing strains. Living culture added directly to the serum, the growth from a whole glucose agar tube to 1.5 c.c. of 1 in 50 dilution, gave little increase with any but M 12, which absorbed completely.

M 9 serum.—The suspensions were increased to 20 mg. per c.c.; the absorption results were as before.

In an absorption experiment with M 10 serum the living growth from a whole slope (about 30—40 mg.) of each of the strains, M 14, 15, 36, and 41, was added to 1·5 c.c. of 1 : 50 dilution without effecting the least reduction of the agglutinin acting on M 10, although these strains were agglutinated to a high titre by this serum.

M 17 serum.—The addition of a whole living slope culture to 1 c.c. of 1 : 25 dilution caused complete absorption in the case of M 10, 12, 13, 17, 40, and 43, as before; there was very slightly increased absorption with some of the other strains, but none with M 11, 36, and 41. A whole slope culture in 1 c.c. of 1 : 50 dilution gave a similar result. Still larger quantities up to 2 tubes per c.c. of 1 : 50 caused some reduction with M 1—9, but none with M 11, 36, 41, and 46.

The above experiments confirm the previous conclusion that the agglutinins in the various Group I sera with which the tests were made belong to three varieties with different combining qualities.

Additional observations on absorptive capacities of Group I spinal strains.

As shown in the tabular summary, p. 68, three of the 20 strains which absorbed from one or other of the Group I sera were found to combine with all three agglutinins, designated A, B, and C. Sera were available from two of these strains, M 10 and M 43, and it is interesting to find that at least two of the agglutinins can be demonstrated in each of the sera, *i.e.*, there is a correspondence between absorptive and agglutinogenic capacity. Some experiments with M 10 and M 43 sera will now be described. They show incidentally that changes in the absorptive capacity of certain strains occurred during cultivation; in addition, these experiments serve to complete the classification of the remaining spinal meningococci and to define more accurately their position in the series in which Group I antigen predominates.

M 43 *serum.*

In Table VIII two separate experiments with M 43 serum are recorded.

TABLE VIII.

M 43 *serum absorbed with* 22 *spinal strains. Titre of absorbed and unabsorbed serum tested on homologous strain (different suspensions).*

Method.—Experiment 1: 2 mg. of culture (heated suspension) per c.c. of 1 in 50. Experiment 2: Growth from a whole tube, 30-40 mg., added to 1·5 c.c. of 1 in 100 serum.

	Experiment 1.				Experiment 2.			
Absorbing Strain.	Test on M 43 Suspension A.				Test on M 43. Suspension B.			
	200	400	800	1,600	200	400	800	1,600
*Nil	+	+	+	+	+	+	+	±
M 1	±	±	—	—	±	±	±	tr.
M 2	+	+	tr.	—	±	±	±	tr.
M 3	+	+	+	tr.	±	±	±	±
M 4	±	—	—	—	±	±	±	—
M 5	±	±	—	—	±	±	±	—
M 6	+	+	+	+	+	+	±	±
M 7	+	±	tr.	—	±	±	±	tr.
M 8	±	±	—	—	...	...	...	...
M 9	+	±	±	—	±	±	tr.	—
M 10... ...	+	±	tr.	—	+	+	±	±
M 11... ...	+	+	+	±	±	±	±	tr.
M 12... ...	+	+	+	+	—	—	—	—
M 13... ...	+	+	+	+	—	—	—	—
M 14... ...	+	+	+	+	—	—	—	—
M 15... ...	+	+	+	±	±	±	±	tr.
M 16... ...	+	+	+	±	±	±	±	tr.
M 17... ...	+	+	+	+	—	—	—	—
M 36... ...	+	+	+	±	±	±	±	±
M 40... ...	+	+	±	—	—	—	—	—
M 41... ...	+	+	+	+	±	±	±	tr.
M 43... ...	+	±	tr.	—	—	—	—	—
M 46... ...	+	+	+	+	...	...	...	...

* In this and succeeding tables Nil signifies that the test is upon unabsorbed serum.

The first experiment shows that the homologous agglutinin has been reduced by certain strains. A further investigation (not recorded in the table) was then made in order to render the experiment more complete, as in the case of M 10 serum (Table VII). Each heated suspension was again added to the absorbed dilutions, now 1:50. The test of this second absorption (not reproduced) was made on a different suspension of M 43 from the one used for the first. The result was unexpected. Instead of the agglutinating power of the serum being further reduced by those strains which absorbed after a single application of culture, it was in some cases apparently increased. On the other hand, certain strains, *e.g.*, M 12, 13, and 17, which had not at first exhibited any combining affinity for the homologous agglutinin, after the second addition absorbed the whole.

In the second experiment of Table VIII the absorption of M 43 serum was repeated with larger amounts of living culture added to the serum diluted to 1:100. Again the result was different from that in the first half of the table. Two strains, M 40 and M 43, which had absorbed partially at first, now absorbed the agglutinin completely; and, in addition, four strains, M 12, 13, 14, and 17, which had before shown no absorbing power, now effected complete absorption. The remaining strains absorbed slightly.

In seeking an explanation of these anomalous results, it was noted that the suspensions of M 43 used to test the result of absorption in the two last mentioned experiments were not the same as in the first (shown in Experiment 1 of the table), and it appeared possible that it was to this fact that the irregularity in absorption might be attributed. The exact reason of the variability did not suggest itself until it was found that later sub-cultures of M 43 differed from the earlier in absorptive capacity. This discovery at once suggested the following explanation, on the hypothesis that the antigens of M 43 had been modified during sub-culture:—

(1) The original culture contained the two antigens A and B.
(2) The serum produced with this culture contained the agglutinins corresponding to both A and B.
(3) After prolonged sub-culture changes took place in two directions, (*a*) some strains losing the A type of antigen and (*b*) others losing the B type.

The evidence in support of this is:—

(1) The original culture absorbed the agglutinin from an A type of serum (M 1 serum) and also from a B type of serum (M 17 serum).
(2) From M 43 serum, which agglutinated M 1 and M 17 equally, A agglutinin was removed by M 1 whilst B agglutinin was left behind, and B agglutinin was removed by M 17, whilst A agglutinin was left behind. (See p. 73).
(3) One of the later cultures of M 43 absorbed the B agglutinin from M 17 serum, but failed to absorb the A agglutinin from M 1 serum or from M 43 serum.

    Another of the later cultures absorbed the A agglutinin from M 1 serum, but failed to absorb the B agglutinin from M 17 serum or from M 43 serum.

In the light of this explanation the results recorded in Table VIII may be interpreted. In the first experiment the culture of M 43 used for testing the absorbed serum contained A antigen alone or in predominance, and consequently registered only the absorption of agglutinin by strains possessing A antigen (the strains M 1, etc.). In the second experiment (Table VIII) the absorbed serum was tested with a culture of M 43, which contained mainly B antigen, and consequently registered only the absorption of agglutinin by organisms possessing B antigen (strains M 17, etc.).

Whether the two components of M 43 were present as separate individuals in the cerebro-spinal fluid of the case, or whether they are descendants from a single coccus has not been determined. There is evidence that one of the daughter strains is either still a mixture or still capable of variation, since one strain which absorbed A agglutinin but not B now absorbs B but not A. It may be assumed therefore that the differences in absorptive capacity between different sub-cultures depend upon the predominance of one or the other component.

The same explanation serves to account for another series of absorption tests, the results of which were at first puzzling. M 43 serum was absorbed with various strains, including M 43, and then tested on M 7, a strain possessing A antigen. It was found that the M 43 strain failed to remove agglutinin for M 7. The reason, as is now evident, was that the particular strain of M 43 which was used for absorption did not contain much A antigen, and therefore behaved like the strains M 12, 13 and 17 (also known to possess little A antigen), and unlike M 5 (known to possess A antigen), which was found to remove the agglutinin for M 7.

In order to complete the classification of the remaining Group I strains the method illustrated in Table IX was used to ascertain by which of the two agglutinins (A or B) in M 43 serum the agglutination of a particular strain containing one of the corresponding antigens was produced. The tests with the strains M 11, 14 and 15 containing only C antigen are inserted as controls. Evidently M 1 contains A antigen and not B antigen, as it removes the agglutinin for M 8, but not the agglutinin for M 59; for the converse reason the strains M 12, 13 and 17 contain B antigen but not A. This method of utilising the A and B components of the agglutinins in M 43 serum has been applied to 5 other spinal strains of Group I, and has demonstrated that strains M 48, 52 and 53 contain A antigen but not B, and that the strains M 50 and M 56 contain B antigen but not A.

TABLE IX.

M 43 *serum absorbed with spinal strains representing* 3 *sub-groups of Group I. Serum titrated before and after absorption and tested on M* 43 (*homologous*), *M* 8 (*combines with agglutinin A*), *M* 59 (*combines with agglutinin B*).

Method.—5 mg. of culture (unheated suspension) per c.c. of 1 in 50 serum.

Absorbing Strain.	Test on M 43.				Test on M 8.				Test on M 59.			
	100	400	800	1,600	100	400	800	1,600	100	400	800	1,600
Nil ...	+	+	±	±	+	+	+	—	+	+	+	±
A M 1 ...	±	±	±	—	—	—	—	—	+	+	+	±
B { M 12 ...	±	±	±	—	+	+	+	—	—	—	—	—
B { M 13 ...	±	±	tr.	—	+	+	±	—	—	—	—	—
B { M 17 ...	±	tr.	—	—	+	+	+	—	—	—	—	—
C { M 11 ...	+	+	±	tr.	+	+	+	—	+	+	+	±
C { M 14 ...	+	+	±	±	+	+	±	—	+	+	+	±
C { M 15 ...	+	+	±	±	+	+	+	—	+	+	+	±

Certain other points of interest appear in Table IX with reference to M 43 serum and culture. The test suspension of M 43 seems to contain a proportion of A antigen as well as B, though the latter preponderates.

Although M 43 culture originally absorbed all three agglutinins, the serum produced with M 43 does not contain much C agglutinin. (*See* Table I for its action upon M 11, 14 and 15.) It is possible that immunisation was not carried far enough to develop this agglutinin from the antigen shown by the original absorption test to be present.

M 10 *Serum.*

M 10 was a Group I strain with very complete antigenic properties. The evidence of this is found in the following observations, which have already been referred to; it absorbed all three agglutinins of Group I and produced a serum which agglutinated all the Group I spinal strains (see Table I). In the preceding section it has been shown that M 43 serum contained two agglutinins, A and B, and that the Group I strains could be divided according as they (1) picked out A agglutinin only; (2) B agglutinin only; or (3) failed to remove either agglutinin. Among the last-mentioned there were seven strains which possessed in addition to the above negative characteristic the capacity to absorb readily the homologous agglutinin from M 15 serum, *i.e.*, C agglutinin.

TABLE X.

M 10 *serum absorbed with spinal strains to show the presence of two agglutinins, A and C. Serum titrated before and after absorption and tested on M* 10 *and M* 14.

Method.—One tube of culture, 30-40 mg., added to 2.5 c.c. of 1 in 50 serum.

Absorbing Strain.	Test on M 10.				Test on M 14.		
	200	400	800	1,600	200	400	800
Nil	+	+	+	+	+	+	±
M 11	+	+	+		—	—	—
M 14	+	+	+		—	—	—
M 15	+	+	±		—	—	—
M 36	+	+	+		—	—	—
M 41	+	+	+		+	+	tr.
M 65	+	+	+		tr.	—	—
M 51	+	+	+		—	—	—
M 43	—	—	—		—	—	—
M 10	—	—	—		—	—	—

Following the method just described in dealing with M 43 serum, it can be shown (Table X) that these seven strains, excepting M 41, which are not differentiated by simple agglutination tests with M 10 serum from the other two sub-groups, A and B, of Group I, fail to absorb the homologous agglutinin A from M 10 serum, but remove the agglutinin for M 14, *i.e.*, C agglutinin.

M 41 originally gave the same reactions as the other six strains. In the experiments at this stage it had become more agglutinable, but large amounts of culture were required to remove the agglutinin for itself. When this was effected the agglutinin for other members of the sub-group C was also removed.

It will be seen from Table XI that while M 1 removes C agglutinin from M 10 serum, the three strains, M 12, 13, and 17, fail to remove this agglutinin. But these three strains have been shown to absorb the homologous agglutinin from M 15 serum, the type serum for C agglutinin, and yet they cannot absorb from M 10 serum an agglutinin with similar combining affinities.

TABLE XI.

M 10 *serum absorbed with the same spinal strains as in Table IX. Serum titrated before and after absorption and tested on M* 15 *and M* 41 *(strains which combine with C agglutinin).*

Method.—5 mg. of culture (unheated suspension) per c.c. of 1 in 50 serum.

	Absorbing Strain.	Test on M 15.					Test on M 41.				
		100	200	400	800	1,600	100	200	400	800	1,600
	Nil	+	+	+	+	±	+	+	+	+	±
A	M 1 ...	tr.	—	—	—	—	+	+	tr.	—	—
B	M 12 ...	+	+	+	+	tr.	+	+	+	±	tr.
B	M 13 ...	+	+	+	+	tr.	+	+	+	±	±
B	M 17 ...	+	+	+	+	tr.	+	+	+	+	±
C	M 11 ...	+	+	±	—	—	+	+	±	tr.	—
C	M 14 ...	+	+	±	—	—	+	+	±	tr.	—
C	M 15 ...	±	±	tr.	—	—	+	+	±	tr.	—

Assuming that in a particular strain the antigens concerned in the absorption of several agglutinins are separable substances, M 10 (combines with A and C agglutinins) and M 17 (combines with B and C agglutinins) may be represented thus in relation to M 15 serum:—M 10 (C antigen) absorbs M 15 agglutinin, M 17 (C antigen) absorbs M 15 agglutinin, but M 17 (C antigen) cannot absorb the agglutinin produced by the C antigen of M 10. In explanation it may be conjectured that the antigens of M 10 and M 17, which are alike in their capacity to absorb the agglutinin from M 15 serum, possess differences in structure which are minor but sufficient to constitute a bar to the combination of the agglutinin produced by one with the antigen of the other. Similar instances of such relationship between two antigens have been found, and are reviewed in the section on variability of strains (p. 90). They serve to emphasise the need for caution in taking as a basis for division of strains into types the differences in absorptive capacities in relation to a single serum.

Comparison between absorptive capacities of Group I and Group II cerebro-spinal strains.

Out of the first 46 strains of spinal meningococci, 22, as previously stated, were selected from the results of the agglutination tests for absorption experiments with Group I sera, and all but two, M 16 and M 46, were shown to contain antigens capable of combining with the Group I agglutinins. The remaining 24, all of which were agglutinated by the Group II sera, will now be compared in respect of their capacity for absorbing agglutinin from those sera.

The method of absorption adopted in defining the agglutinins of Group I, that is, the addition of a heated suspension containing 4 mg. of culture per c.c. to an equal volume of 1 : 25 dilution of serum, was not found suited to the absorption of Group II agglutinins, since so little impression was made even with the homologous strain. It was found necessary to use larger amounts of culture.

TABLE XII.

M 23 serum and M 24 serum (both Group II) absorbed with spinal strains of Group II. Each serum titrated and tested before and after absorption on the respective homologous strain.

Method.—M 23 serum: 1·5 of 1 in 25 serum + growth from whole ascitic agar tube, approx. 30 mg. M 24 serum: 3 mg. of culture (heated suspension) per c.c. of 1 in 50 serum.

Absorbing Strain.	M 23 Serum. Test on M 23.				M 24 Serum. Test on M 24.			
	100	200	400	800	100	200	400	800
Nil	+	+	+	+	+	+	+	±
M 18	±	±	±	tr.	±	±	tr.	—
M 19	±	±	±	tr.	+	+	±	tr.
M 20	±	±	tr.	—	±	tr.	tr.	—
M 21	±	±	±	—	±	±	tr.	—
M 22	±	±	±	—	±	±	±	tr.
M 23	±	±	±	±	±	tr.	—	—
M 24	±	±	±	±	tr.	tr.	—	—
M 25	±	±	±	tr.	±	tr.	tr.	—
M 26	±	tr.	—	—	±	±	tr.	tr.
M 27	±	±	±	tr.	+	±	tr.	—
M 28	+	±	±	tr.	tr.	tr.	tr.	—
M 29	tr.	tr.	tr.	—	±	±	tr.	—
M 30	±	tr.	tr.	—	±	tr.	tr.	—
M 31	+	+	+	+	+	+	+	±
M 32	+	+	+	+	+	+	+	tr.
M 33	+	+	+	+	+	+	+	±
M 34	+	+	±	tr.	+	±	tr.	tr.
M 35	+	±	±	tr.	±	tr.	tr.	—
M 37	—	—	—	—	±	tr.	—	—
M 38	tr.	—	—	—	±	±	tr.	—
M 39	±	±	tr.	—	±	±	tr.	tr.
M 42	+	+	±	tr.	+	±	±	tr.
M 44	±	±	tr.	tr.	±	tr.	tr.	—
M 45	+	±	tr.	tr.	±	±	tr.	tr.

In Table XII the results with M 23 and M 24 sera are given. The amount of absorption from M 23 serum ranges from slight diminution of agglutination in the highest dilutions in the case of M 35 to complete absorption with M 37. After absorption with certain strains including the homologous, the test suspension was still agglutinated to the same height as before absorption, but agglutination was incomplete in every dilution. Three strains only, M 31, 32, and 33, failed to absorb any of the agglutinin for M 23. A similar result was obtained with M 24 serum, the same three strains again failing to absorb appreciably. Thus 21 out of the 24 strains showed similar but not identical absorbing capacities in relation to the two Group II sera.

Comparing the absorption experiments with Group I sera, it was found that one serum, M 15, was absorbed by all except two

of the 22 strains in Group I. But absorption experiments upon sera prepared with other individuals of the 20 strains showed that these could be divided into three sub-groups. Similarly, the Group II strains may be subdivided according to their absorptive capacities for the various Group II sera. M 18, for example, produced a serum from which only a minority of the above strains extracted an appreciable amount of homologous agglutinin.

Table XIII shows that there are at least four different Group II agglutinins. Four sera were absorbed, each with the

TABLE XIII.

Four Group II sera absorbed with the same suspensions of nine spinal strains. Each serum titrated before and after absorption and tested on the respective homologous strain.

Method.—M 32 serum: 10 mg. of culture per c.c. of 1 in 100. M 18 serum: 10 mg. of culture per c.c. of 1 in 100. M 33 serum: 10 mg. of culture per c.c. of 1 in 100. M 24 serum: 5 mg. of culture per c.c. of 1 in 50.

Absorbing Strain.	M 32 Serum.			M 18 Serum.				M 24 Serum.				M 33 Serum.			
	Test on M 32.			Test on M 18.				Test on M 24.				Test on M 33.			
	200	400	800	200	400	800	1,600	100	200	400	800	200	400	800	1,600
Nil	+	+	+	+	+	+	+	+	+	+	+	+	+	+	±
M 9	+	+	±	+	+	+	+	+	+	+	tr.	+	+	tr.	—
M 18... ...	+	+	±	—	—	—	—	±	±	tr.	—	±	±	tr.	—
M 20... ...	+	+	±	+	+	+	±	+	+	±	—	+	+	±	tr.
M 21... ...	+	+	±	+	+	+	±	+	±	tr.	—	+	+	±	tr.
M 24... ...	+	+	±	+	+	+	±	tr.	—	—	—	±	tr.	tr.	—
M 31... ...	+	+	±	+	+	+	+	+	±	tr.	—	±	±	tr.	tr.
M 32... ...	—	—	—	+	+	+	±	+	±	tr.	—	+	±	±	tr.
M 33... ...	+	+	±	+	+	±	—	+	+	tr.	—	±	tr.	—	—
M 42... ...	+	+	tr.	+	+	+	±	tr.	—	—	—	+	+	±	tr.

same suspensions of the same strains; the amount of culture used was sufficient or almost sufficient to exhaust the sera in the case of the respective homologous strains. Among those strains not absorbing the homologous agglutinin of M 18 serum is M 24, although M 18 was found to absorb the agglutinin from M 24 serum; this relationship between two strains and their respective sera has been repeatedly observed. M 31, 32, and 33 are seen to be capable of partially absorbing M 24 serum when added in larger amounts than were used previously (Table XII). Complete absorption of M 18 and M 32 sera was effected only by the homologous strains. M 33 agglutinin was absorbed to some extent by all the strains, including M 9 (Group I), thus connecting the two groups.

A further link between the two groups is shown in Table XIV. M 24 serum was absorbed, titrated, and tested on three strains of Group II, the dilutions being identical in each case. It is

TABLE XIV.

M 24 serum (Group II) absorbed with seven spinal strains representing three sub-groups of Group I. Serum titrated before and after absorption and tested on M 18, M 61, and the homologous strain (all Group II).

Method.—10 mg. of culture (unheated suspension) per c.c. of 1 in 50 serum.

Absorbing Strain.	Test on M 24.				Test on M 18.				Test on M 61.			
	100	200	400	800	100	200	400	800	100	200	400	800
Nil	+	+	+	±	+	+	+	±	+	+	+	+
M 1	+	+	±	±	+	+	+	±	+	+	+	±
M 12	+	+	±	±	+	+	+	±	+	+	+	±
M 13	+	+	+	±	+	+	±	±	+	+	+	±
M 17	+	+	±	±	+	+	+	±	+	+	+	±
M 11	+	+	±	—	+	+	±	tr.	+	+	+	±
M 14	+	±	±	—	+	+	±	tr.	+	+	+	±
M 15	+	±	±	—	+	+	±	tr.	+	+	+	tr.

TABLE XV.

M 24 serum absorbed with increased quantities of three spinal strains (see Table XIV). Titre of serum before and after absorption for the homologous strain.

Method.—Growth from one tube to 2 c.c. of 1 in 50.

Absorbing Strain.	Test on M 24.			
	100	200	400	800
Nil	+	+	+	±
M 11 ...	±	tr.	tr.	—
M 14 ...	+	±	tr.	—
M 15 ...	+	+	tr.	—

seen that the Group I strains, M 11, 14, and 15 removed from the serum a little of the agglutinin for M 24 and a trace for M 18. With larger amounts of culture the absorption of M 24 agglutinin was increased (Table XV).

Agglutinin absorption with naso-pharyngeal strains.

The preceding experiments on absorption with spinal meningococci have shown that many differences exist between the absorptive capacities of different strains and that for the accurate definition of these a large number of sera is required. This fact, on the one hand, indicates that the difficulty will necessarily be as great, and is likely to be greater, in applying the same methods to the identification of many of the naso-pharyngeal strains with meningococci from the cerebro-spinal fluid of cases of meningitis; and, on the other hand, it emphasises the danger of error in excluding the former from the

meningococcus species on the grounds of their failure to absorb agglutinin from a few standard sera. In the light of the data ascertained as to the combining affinities of the agglutinin in a number of spinal meningococcus sera, the present task is to compare the combining capacities of the pharyngeal strains for those agglutinins, or, alternatively, to test the absorbing power of spinal strains upon sera prepared with pharyngeal strains. The spinal Group II agglutinating sera, with which a large number of pharyngeal strains have been shown to react (Table II), will be dealt with in the first place.

Relationship of the naso-pharyngeal strains to the agglutinins of Group II.

(1) *Tests with M 24 serum*—

The majority of the pharyngeal strains which were agglutinated by M 24 serum were tested as to their absorptive capacity for the homologous agglutinin. It was found that M 24 itself reduced the agglutinating titre of the serum below 1-100, when added in the proportion of 5 mg. of culture to each c.c. of 1–50 dilution of serum; and this method was adopted in the case of the pharyngeal strains. For the sake of condensation only a few of the results are given in tabular form. These are representative of the whole series and are shown in Table XVI, from which it will be seen that some strains caused complete absorption, some partial, and others were negative. The absorbed dilutions were titrated in duplicate and were tested on M 23 as well as on the homologous strain; the results as a rule agreed.

TABLE XVI.

M 24 serum absorbed with 13 *naso-pharyngeal strains. Serum titrated before and after absorption and tested on M* 24 *and M* 23.

Method.—5 mg. of culture (unheated suspension) per c.c. of 1 in 50 serum.

Absorbing Strain.	Test on M 24.			Test on M 23.			
	100	200	400	100	200	400	800
Nil	+	+	+	+	+	+	+
N.P. 1 ...	+	+	+	+	+	+	+
N.P. 3 ...	+	+	+	+	+	+	+
N.P. 8 ...	±	tr.	—	+	+	±	tr.
N.P. 10 ...	tr.	—	—	+	+	±	—
N.P. 47 ...	±	tr.	tr.	+	±	tr.	—
N.P. 58 ...	+	+	+	+	+	+	±
N.P. 60 ...	+	+	±	+	+	+	tr.
N.P. 72 ...	—	—	—	—	—	—	—
N.P. 73 ...	tr.	tr.	—	+	+	±	—
N.P. 78 ...	—	—	—	+	+	tr.	—
N.P. 80 ...	±	tr.	—	tr.	—	—	—
N.P. 87 ...	tr.	tr.	—	—	—	—	—
N.P. 85 ...	±	tr.	—	+	+	±	—

The following is a summary of the complete results by this method of absorption:—

Total strains tested, 58.

Negative: 10 strains (NP 1, 3, 15, 19, 21, 33, 46, 58, 71 and 86).

Definitely positive, *i.e.*, reduction in titre to incomplete at 1:100: 23 strains (NP 7, 8, 9, 10, 28, 34, 35, 37, 38, 45, 47, 50, 62, 72, 73, 74, 78, 80, 83, 85, 87 and 89).

Slight absorption: 25 strains. The absorption with these was generally increased with larger quantities of culture; for example, the whole growth from a glucose ascitic slope added to 1 c.c. of 1-50 completely exhausted the serum in the case of NP 2, 20, 23, 25, 26 and 27. If spinal and pharyngeal strains agglutinated by Group II sera are compared as a whole, there will be found close agreement in respect of their absorbing capacities for the homologous agglutinin of M 24 serum. It was shown that 21 out of 24 agglutinating spinal strains definitely absorbed the agglutinin from this serum, and the remaining three also absorbed when the amount of culture was increased.

(2) *Tests with M 18 serum*—

This serum agglutinated 32 out of the 86 pharyngeal strains to 1-400 or over. The absorptive capacities of 15 were tested in relation to this serum. Seven of these, NP 46, 58, 64, 72, 78, 85 and 87, failed to absorb the homologous agglutinin. The results with the 8 other strains are shown in Table XVII, in which are included for comparison 9 spinal strains of Group II. The table is arranged in a different manner from any of the others. The first column enumerates the pharyngeal and spinal strains agglutinated by the serum, before absorption up to 1-800 at least, each suspension being the same throughout the experiment. The rest of the table shows that certain of these strains agglutinated (+) and others failed to agglutinate (−) in a dilution of 1-200 after absorption with the strain at the head of each column. Thus in the second column, showing the results of absorption with NP 10, all except NP 40 failed to agglutinate in 1-200. The amount of culture used for absorbing extracted completely (*i.e.*, in the highest concentration of serum tested) the agglutinin for the absorbing strain in every instance excepting NP 35; in a few cases where the results were not quite sharp, a trace of agglutination was taken as negative and a marked though incomplete reaction as positive.

TABLE XVII.

M 18 serum absorbed with spinal and pharyngeal strains.

Method.—10 mg. of culture (unheated suspension) per c.c. of 1 in 100 serum. All the strains in the first column were agglutinated to 1 in 800 at least before absorption. Table shows the agglutination (+ or −) in 1 in 200 dilution after absorption with the strains at the head of each succeeding column after the first.

	NP 10	NP 28	NP 35	NP 54	NP 80	NP 48	NP 73	NP 40	M 64	M 66	M 22	M 33
NP 10	—	+	+	+	—	—	+	+	+	—	—	+
NP 28	—	—	+	—	—	—	+	+	—	+	—	—
NP 35	—	+	+	—	—	—	—	+	+	—	—	+
NP 54	—	—	+	—	+	—	+	+	—	+	—	—
NP 80	—	+	+	—	—	—	—	+	+	—	—	+
NP 48	—	+	+	+	—	—	+	+	+	+	—	+
NP 73	—	—	+	—	—	—	—	+	+	—	—	+
NP 40	+	+	+	—	+	—	+	—	—	—	+	—
M 18	—	+	+	—	—	—	—	+	+	+	—	+
M 27	—	+	+	—	—	—	+	+	+	+	—	+
M 61	—	+	+	—	—	—	+	+	—	+	—	+
M 33	—	—	+	—	—	—	+	+	—	+	—	—
M 26	—	+	+	+	+	—	+	+	+	+	—	+
M 28	—	+	+	+	—	—	—	+	+	—	—	+
M 29	—	+	+	+	—	—	+	+	+	—	—	+
M 37	—	+	+	—	—	—		+	+	—	—	+
M 44	—	+	—	—	—	—	—	+	+	—	—	+

The results show that five pharyngeal strains, NP 10, 54, 80, 48 and 73, and one spinal strain, M 22, have removed the agglutinin for themselves and at the same time the homologous agglutinin. They differ in capacity for absorbing agglutinins which act upon strains other than the homologous. This somewhat anomalous result may be due to incomplete exhaustion of the serum and the presence of small quantities of agglutinin still remaining, which influences some strains more strongly than others. The strains can be arranged in a series with diminishing capacity for absorption; NP 48 absorbs the agglutinin for all the strains in the left hand column, and is followed closely by NP 10 and M 22, while NP 40 removes only the agglutinin for itself.

Certain conclusions are to be drawn from these results. (1) No distinction can be made between the spinal and pharyngeal strains; (2) grouping by this method of absorption is indistinct; and (3) differences in absorptive capacity are revealed.

(3) *M 32 serum and M 33 serum*—

Certain pharyngeal strains agglutinated by the above two sera were identified by absorption tests with the spinal strains which produced these sera.

M 32 serum was absorbed with that amount of culture which sufficed in the case of the homologous strain to remove the agglutinin for itself. With this quantity three spinal strains, M 23, 38 and 66, and three pharyngeal strains, NP 5, 12 and 81 removed completely the homologous agglutinin.

The agglutinin from M 33 serum was completely removed by M 24, NP 62 and NP 39. Under the same conditions certain other spinal and pharyngeal strains reduced the homologous agglutinin from 1-1,600 to 1-800 and 1-400.

Summary.

A general survey of these results shows that 33 of the 86 pharyngeal strains have exhausted the homologous agglutinin of one or more of the four Group II spinal sera. No less than 29 other pharyngeal strains, not included in the above 33, were agglutinated up to 1:400, or in even higher dilutions. It has not seemed to me a profitable task, considering the range of variation in absorptive capacity of the spinal strains themselves, to attempt to "place" all these strains. I am of the opinion that the results obtained are sufficient to justify the conclusion that a strain which agglutinates to 1:400 with one or more sera of Group II will be found to absorb agglutinin from some one or other Group II serum.

Relationship of pharyngeal strains to the agglutinins of Group I.

The simple agglutination tests summarised in Tables I and II have shown that the proportion of strains in the pharyngeal series which are agglutinated completely to 1-400 and over by Group I sera is much lower than that in the spinal series, comprising in the latter 27 out of 66 strains, and in the former 8 out of 86. Evidence of affinities in the pharyngeal strains with the spinal antigen of Group I, though not revealed by simple agglutination, has been indicated by the agglutinogenic tests, and confirmation is furnished by the experiments on agglutinin absorption. The results with a number of pharyngeal strains, in which such evidence has been sought, are summarised in Table XVIII. The agglutination reactions of the above strains to the two group sera are contrasted with their capacities to absorb agglutinin from these sera and to produce agglutinin for spinal strains of Group I. For convenience, the associated affinity, when demonstrated, with spinal sera of Group II is included in the table and will be discussed later.

TABLE XVIII.

Table showing evidence of serological relationship of naso-pharyngeal strains to spinal strains of Group I, and associated affinity with Group II strains.

Strains.	Highest Agglutination with sera of Group I.	Highest Agglutination with sera of Group II	Absorptive and Agglutinogenic Relationship to Group I.	Affinity with Group II.
NP 1	1:800	—	M 1 and M 15 sera completely absorbed.	
NP 53	1:1000	1:200	M 1 and M 15 sera completely absorbed.	
NP 67	—	1:200	M 17 and M 43 sera partially absorbed.	
NP 2	1:400	1:400	M 16 serum completely absorbed.	M 24 serum partially absorbed.
NP 3	1:400	1:400	M 17 and M 43 sera partially absorbed.	
NP 4	1:400	1:800		M 33 serum absorbed by NP 4.
NP 65	1:1000	1;800		
NP 41	1:400	1:400	Produces agglutinin for Group I. NP 41 serum completely absorbed by M 15.	Produces agglutinin for Group II.
NP 5	1:200	1:400	M 17 and M 43 sera partially absorbed.	M 32 serum completely absorbed: M 24 and 33 sera partially absorbed.
NP 40	1:100	1:1000	Produces agglutinins for Group I. M 15 serum completely absorbed.	Produces agglutinins for Group II. M 24 and 33 sera partially absorbed.
NP 71	1:200	1:100	M 17 and M 43 sera partially absorbed.	
NP 11	—	1:200	Produces agglutinins for Group I. M 17 serum partially absorbed. N.P. 11 serum completely absorbed by M 17 and M 46.	Produces agglutinins for Group II.
NP 36	—	1:400	Both produce agglutinins for Group I.	Produce agglutinins for Group II.
NP 43	—	1:400	NP 43 serum completely absorbed by M 46.	
NP 82	—	—	M 43 and M 10 sera partially absorbed.	
NP 86	—	—	M 43 serum partially absorbed.	
NP 44	—	1:100	Produces agglutinins for Group I. N.P. 44 serum absorbed by M 48, Group I.	Produces agglutinins for Group II. M 33 serum partially absorbed.

It will be seen from this table that the three pharyngeal strains, NP 1, 53 and 40, were capable of binding one or more of the Group I agglutinins, A, B and C. NP 1 and 53 removed the agglutinins for M 1 and M 15 (*i.e.*, A and C agglutinins), and NP 40 removed the agglutinin for M 15 (*i.e.*, C agglutinin only). As regards B agglutinin (corresponding to M 17 antigen), no pharyngeal strain is quite equal to M 17 in capacity for absorbing B agglutinin from M 17 serum, but partial though distinct absorption was produced by several strains. The results are given later in detail.

A few pharyngeal strains therefore possess, like all but two of the spinal Group I strains, capacity to absorb one or more of the three Group I agglutinins. The two exceptional spinal

strains which failed in this capacity are M 16 and M 46. The question now arises whether there are in the naso-pharyngeal series strains which stand in the same relation as M 16 and M 46 to the majority of the spinal Group I strains, *i.e.*, possess antigens related to but not identical with those producing the three agglutinins of Group I. It has been found, as indicated in the table, that these specialised antigens of M 16 and M 46 are represented respectively in two pharyngeal strains, NP 2 and NP 43. The method of identification is described in the following experiments in which each strain is dealt with separately:—

NP 2.

NP 2, which was agglutinated by Group I and Group II sera, absorbed partially the homologous agglutinin both from M 24 and M 33 serum (Group II), but did not remove any of the three agglutinins of Group I. M 16 serum (titre 1:1,600), agglutinated NP 2 to 1:800. From this serum NP 2 absorbed the homologous agglutinin almost as well as M 16 itself. The only spinal strains which absorbed M 16 agglutinin were M 15 and M 36, and they only reduced the titre from 1:1,600 to 1:400 by a single application of culture.

NP 43.

In Table XIX M 46 is shown to be almost identical with NP 43 in its capacity for absorbing the homologous agglutinin from NP 43 serum. No other single spinal strain tested was found to remove completely the homologous agglutinin, even when added in large amounts and on successive occasions.

TABLE XIX.

NP 43 serum absorbed with 12 spinal strains. Titre of serum before absorption (1 in 1,600) and after absorption when tested on the homologous strain.

Method.—10-20 mg. of living culture per c.c. of 1 in 50 serum.

Absorbing Strain.	Test on NP 43.		
	100	400	800
Nil	+	+	+
M 9	+	+	+
M 12	+	+	+
M 15	+	+	+
M 16	+	+	+
M 17	+	+	+
M 18	+	+	±
M 24	+	+	±
M 32	+	+	+
M 33	+	+	+
M 38	+	+	+
M 46	±	tr.	—
M 64	+	+	+
NP 43	tr.	tr.	—

Relationship of other pharyngeal strains to spinal strains.

NP 11.

NP 11 was nearly two years in culture, during which it underwent some modification. Originally it was agglutinated by Group II sera and not by Group I. A serum prepared with it agglutinated more strongly the spinal strains of Group I than those of Group II. After a time NP 11 lost its agglutinability to its own serum and a second serum was prepared from it. The second serum was much more quickly produced than the first, and attained a titre of 1-2,000. This serum, five times the titre of the first, only agglutinated up to 1-100 those spinal strains of Group I which were agglutinated to the full titre of the first serum. In Table XX is given an absorption experiment with

TABLE XX.

NP 11 serum absorbed with five spinal strains. Serum titrated before and after absorption and tested on M 10, M 56 and NP 11.

Method.—20 mg. of living culture per c.c. of 1 in 50 serum.

Absorbing Strain.	Test on M 10.			Test on M 56.				Test on NP 11.	
	100	200	400	100	200	400	800	100	200
Nil	+	+	+	+	+	+	±	+	±
NP 11	—	—	—	±	—	—	—	—	—
M 17	—	—	—	tr.	—	—	—	tr.	—
M 46	—	—	—	—	—	—	—	—	—
M 9	+	±	tr.	+	±	—	—	±	±
M 14	+	+	tr.	+	+	+	—	±	±
M 15	+	+	tr.	+	±	tr.	—	±	±

the first serum, the absorbed dilutions being tested on M 10 and M 56 (Group I) in addition to the homologous strain, which at that time was unfortunately only slightly agglutinable. M 46, which was agglutinated completely to 1-400, absorbed the agglutinin as well as NP 11. It is shown also that M 17 absorbed the agglutinin equally well, although NP 11 can only partially absorb M 17 serum; M 46 was unable to effect any absorption from M 17 serum.

NP 5.

NP 5, which absorbs readily the homologous agglutinin of M 32 (Group II), removes partially M 17 agglutinin (agglutinin B of Group I). Complete absorption of the serum was obtained when the dose of culture was increased beyond that required to exhaust M 17 serum with M 17 itself.

NP 41.

NP 41, which was agglutinated to 1-400 by M 10 serum, did not remove from that serum either the agglutinin for M 10 or that for M 15; it failed also to remove the homologous agglutinin from M 15 serum. A serum prepared with NP 41 agglutinated M 15 and NP 41 equally well, the reaction being complete in 1-400, well-marked in 1-800. It was found that M 15 was identical with NP 41 in removing the homologous agglutinin from that serum. A second interesting anomaly was observed in that the six strains, M 1—M 6, could not remove from NP 41 serum the agglutinin for M 15, although they removed from M 15 serum the agglutinin for M 15 (*see* p. 68).

NP 40.

NP 40 readily removed the homologous agglutinin from M 15 serum, but the spinal strain could not remove the homologous agglutinin from the pharyngeal serum. This relationship is similar to that between NP 41 and M 15, but in the reverse direction.

NP 44.

NP 44 was scarcely agglutinated by any of the spinal sera, but produced a serum which agglutinated to a high titre spinal strains in both groups. The homologous agglutinin of NP 44 serum was absorbed with difficulty, many strains of Group I producing no result. The whole of a plate culture of M 11 added to 2 c.c. of 1 in 50 dilution only reduced the homologous agglutinin from 1-800 to 1-400. Three strains of Group I gave the following result (absorption with 10 mg. of culture per c.c. of 1-100 dilution):—M 48 absorbed completely, M 9 was less effective, and M 41 reduced the titre for the homologous strain from 1-800 to 1-400. These strains varied at different times in their capacity for absorbing the serum. The homologous strain itself required to be added in considerable amounts to the serum to produce marked absorption; for example, after absorption with 20 mg. of culture per c.c. of 1-50 dilution, the homologous strain was still agglutinated to the full titre but incompletely in each dilution.

Pharyngeal strains related to M 17 *and M* 43.

It has been mentioned earlier that a number of pharyngeal strains had a certain combining affinity for agglutinin B in M 17 and M 43 sera. The method of absorption adopted to show the presence of two agglutinins in M 43 serum was followed in the case of certain pharyngeal strains. As shown in Table XXI,

TABLE XXI.

Absorption of M 43 serum with spinal and pharyngeal strains, showing the presence of the two agglutinins A and B. Serum titrated before and after absorption and tested on M 43 and M 12.

Method.—5 mg. of culture (unheated suspension) per c.c. of 1 in 50 serum.

Absorbing Strain.	Test on M 43.				Test on M 12.			
	100	200	400	800	100	200	400	800
Control	+	+	+	±	+	+	+	+
M 51	+	+	+	tr.	+	+	+	+
M 64	+	+	+	+	+	+	+	+
M 65	+	+	+	tr.	+	+	+	±
M 17	+	+	+	tr.	±	tr.	—	—
M 43	tr.	tr.	—	—	+	+	+	...
M 48	±	±	—	—	+	+	+	+
NP 65	+	+	+	tr.	±	±	tr.	—
NP 67	+	+	+	tr.	+	+	tr.	—
NP 69	+	+	+	±	+	+	+	+
NP 71	+	+	+	tr.	+	±	tr.	—
NP 77	+	+	±	tr.	+	+	+	±

M 43 serum was absorbed by five pharyngeal strains and in addition by a number of spinal strains which served as controls. The absorbed serum dilutions were titrated in duplicate and tested on M 43 and M 12. It is shown that M 65, 51, and 64 caused no significant diminution in the agglutinating power of the serum either for M 43 or M 12. M 48 and M 43 absorbed the agglutinin for M 43 (A agglutinin), and left that for M 12 intact, while M 17 absorbed only M 12 agglutinin (B agglutinin). (The suspension of M 43 used contained the component corresponding to M 1, and therefore registered only the absorption of A agglutinin.) Of the pharyngeal strains, NP 65, 67, and 71 reduced by half B agglutinin, *i.e.*, the agglutinin for M 12; the other two pharyngeal strains had practically no effect.

In addition to the above, other strains which partially removed from M 43 serum the agglutinin for M 17 were NP 5, 52, 82, and 86.

A second experiment with M 43 serum is shown in Table XXIa. In this example the absorbed dilutions were tested on M 50, a culture which was shown to exhaust M 17 serum. There was distinct absorption with NP 11 and NP 14 (the latter strain was agglutinated to 1-400 by M 43 serum).

TABLE XXIa.

M 43 serum absorbed with five naso-pharyngeal strains. Serum titrated before and after absorption and tested on M 50 (M 50 absorbed M 17 agglutinin).

Method.—2 mg. of culture (heated suspension) per c.c. of 1 in 100 serum.

Absorbing Strain.	Test on M 50.			
	200	400	800	1,600
Nil	+	+	+	±
NP 2	+	+	±	—
NP 4	+	+	+	+
NP 11	+	±	—	—
NP 14	+	±	—	—
NP 19	+	+	+	±
M 43	tr.	—	—	—

The next step was to absorb M 17 serum with the pharyngeal strains which had been shown as above to be related to M 17 through their absorptive capacity for the agglutinin in M 43 serum, which acts upon M 17. It was found that these pharyngeal strains reduced to a varying extent the homologous agglutinin of M 17 serum, but failed to exhaust it completely. Several, however, extracted completely from M 17 serum the agglutinin for M 12 (identical in absorptive capacity with M 17), and other strains reduced the agglutinin for M 50, a strain similar to M 12.

Briefly stated, the results of experiments of this nature showed that the agglutinins in M 17 serum which acted upon spinal strains related to M 17 in absorptive capacity cannot be a single entity, but must comprise a group of agglutinins differing slightly from each other in combining qualities. The related pharyngeal strains have apparently greater affinity for certain of these agglutinins than for others. This question will be reverted to in the section on variability of serological characteristics.

Evidence of association of Group I and Group II antigens in a single strain.

The agglutination and agglutinogenic tests have shown that both group antigens may be present in a single meningococcus strain, the evidence being most marked in the case of certain less typical spinal strains and in a considerable proportion of the naso-pharyngeal strains. The predominance of one antigen over the other in the typical spinal strains has been generally so definite that cross-absorption tests with their sera have given negative results. The spinal strains of Group I which absorb C but not A or B agglutinin form an exception, since they can remove the agglutinin from M 24 serum (Group II) (*see* Table XV).

Special attention has been directed to those pharyngeal strains which produce agglutinins for spinal strains of both groups and are sometimes agglutinated by both group sera. Reference has already been made to certain of these in Table XVIII, and some details of interest will now be considered.

NP 44 serum agglutinated M 18 (Group II) up to 1:800. M 24 and M 23 readily removed this agglutinin, and M 9 (Group I) reduced it by half. NP 41 agglutinated M 21 (Group II) and M 15 (Group I) removed this agglutinin as well as that for the homologous strain. NP 43 agglutinated a Group II spinal strain, M 61, to 1:800. Two other Group II spinal strains readily absorbed from NP 43 serum the agglutinin for M 61 while only reducing the homologous agglutinin from 1:1,600 to 1:800. M 9 (Group I), on the other hand, absorbed the agglutinin for itself, but did not affect either the agglutinin for M 61 or NP 43.

A further observation of interest in this connection is that a mixture of Group I and Group II strains was often more effective in reducing the homologous agglutinin of one of these pharyngeal sera than either alone. For example, NP 40 serum, which was not completely exhausted by any single spinal strain, was treated with (1) a mixture of Group I suspensions, (2) a mixture of Group II, (3) a mixture of Group I and Group II. The suspensions, the same throughout, were standardised to 4 mg. per c.c., and the serum, diluted to 1:50, received exactly 2 mg. of the mixed cocci per c.c. In (1) and (2) the homologous agglutinin was reduced from 1:800 to 1:400, and in (3) to 1:200.

It may be recalled that the parameningococcus of Dopter, obtained at first from the naso-pharynx and later from the cerebro-spinal fluid of cases of meningitis, sometimes produced a serum which agglutinated both parameningococci and meningococci. Experiments quoted in Dr. Eastwood's Report* showed that parameningococcus serum saturated with meningococci lost its agglutinin for meningococci but retained its agglutinin for parameningococci; while the same serum, saturated with parameningococci, lost its agglutinin for parameningococci but retained its agglutinin for meningococci. If Group I is substituted for meningococcus and Group II for parameningococcus, Dopter and Pauron's results resemble those mentioned with the naso-pharyngeal serum, NP 43. In reports by Ellis and Arkwright† the parameningococcus was identified with their Group II, but Gordon‡ could not establish its identity with any of his types of meningococci. Dopter and Pauron divided their seven strains of parameningococci into three groups by means of saturation tests, and they suggested that perhaps additional varieties might subsequently be found. I am of the opinion that the strains of parameningococci which Dopter found to produce agglutinins for both varieties are like the pharyngeal strains which are agglutinated by Group II sera and produce agglutinins for both Group I and

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* Reports to the Local Government Board (New Series, No. 110), p. 30.
† British Medical Journal, December 18th, 1915.
‡ Gordon and Murray (1915), Journ. R.A.M. Corps, Vol. 25.

Group II. They differ from the commoner examples of cerebrospinal meningococci in being less well-defined in relation to the two main groups.

Variability of strains.

In the course of this investigation some instances of variation have been observed which are of importance in their bearing on the position occupied by the less typical strains in the whole group of meningococci. For the most part, excepting variations in agglutinability and minor alterations in absorptive capacity, the various strains under observation have retained in culture their particular serological characteristics. This is not necessarily proof that they remain unvaried, since the method by which the cultures are maintained, *i.e.*, by the transference of considerable quantities from one tube to another, may not bring to light possible modifications. As it is not to be expected that the culture would vary *en masse,* variations of individual cocci might occur but be overgrown by the predominant organism. Consequently their demonstration demands that individual cocci should be isolated from the general mass of the culture.

An experiment with that object has been made with M 17 culture. This particular strain was chosen because a change was observed in its absorptive capacity towards its own serum. Originally 2 mg. of culture per c.c. of 1-50 serum was sufficient to reduce the agglutinating power of the serum below 1 : 100, but later it was necessary to use much larger amounts to bring about the same result. I therefore endeavoured to ascertain whether all the individual cocci in the culture were identical, the idea having suggested itself that the presence of some with diminished absorptive capacity might account for the necessity of using increased quantities of culture to effect absorption. M 17 was plated and 40 single colonies were grown in subculture. Each of these was used separately to exhaust M 17 serum, and one strain only was found which failed to absorb the agglutinin for the whole culture while removing the agglutinin for itself. The other 39 strains removed the agglutinin for themselves and for the whole culture. The aberrant strain, after remaining in subculture for some time, was again plated. Four single colony strains were grown; three removed the whole agglutinin and one failed. Either the single colony first selected was not from a single organism or a certain number had reverted to the pre dominant type. The last non-absorbing strain, designated M 17 K, was subcultured twice and again plated. Twelve single colonies were grown in subculture.

Table XXII gives the agglutination results with each of these 12 single-colony strains, and demonstrates the absorptive capacity for their own and the homologous agglutinins in M 17 serum. It will be seen that the severe method of absorption

TABLE XXII.

Agglutination and absorption test of M 17 *serum with M* 17 *(whole culture) and* 12 *single-colony strains of M* 17. *Serum before absorption titrated and tested on each strain, and after absorption again on each strain and on the whole culture.*

Method.—Three successive additions to 2 c.c. of 1 in 50 serum: (1) 5-10 mg. of each culture, (2) growth from whole tube two hours later; after centrifuging the clear fluid was pipetted off and (3) growth from a whole tube was again added.

	Before absorption.				After absorption.						
	v. absorbing strain.				*v.* M 17 whole culture.					*v.* absorbing strain.	
	200	400	800	1,600	100	200	400	800	1,600	100	200
M 17 (whole culture)...	+	+	+	+	—	—	—	—	—	—	—
M 17A	+	+	±	—	+	+	+	tr.	—	—	—
M 17B	+	+	±	—	+	+	+	+	—	—	—
M 17C	+	+	+	tr.	+	+	+	tr.	—	—	—
M 17D	+	+	+	tr.	+	+	+	±	—	—	—
M 17E	+	+	±	—	+	+	+	±	—	—	—
M 17F	+	+	+	tr.	+	+	+	+	tr.	—	—
M 17G	+	+	+	tr.	+	+	+	±	—	—	—
M 17H	+	+	+	—	+	+	+	±	tr.	tr.	—
M 17I	+	+	+	—	+	+	+	±	—	—	—
M 17J	+	+	+	tr.	+	+	+	±	—	tr.	—
M 17L	+	+	+	tr.	+	+	+	+	tr.	tr.	—
M 17M	+	+	+	tr.	+	+	+	+	±	—	—

adopted ensures the elimination of mere quantitive differences in absorptive capacity. The whole culture absorbed all the agglutinin for itself, but the single-colony strains, while absorbing completely their own agglutinins, only reduced in some cases very slightly the agglutinin for the whole culture. In simple agglutination the single-colony strains generally reached half the titre of M 17 serum for the whole culture. In this respect they resembled some of the pharyngeal strains previously mentioned which reduced the homologous agglutinin of M 17 serum but failed to exhaust it.

An absorption experiment was carried out with the object of ascertaining whether the agglutinin for the variant of M 17 could be more readily removed from M 17 serum by these pharyngeal strains than the whole agglutinin. In Table XXIII M 17 serum was absorbed with six pharyngeal strains; three spinal strains which do not absorb B agglutinin were included as controls. It will be seen that the agglutinin for the variant, M 17 K, is more readily absorbed by five pharyngeal strains than the whole agglutinin. NP 2, which was shown to absorb M 16 serum, and the three spinal strains had practically no effect. The test suspension of M 17 K was composed of a

TABLE XXIII.

M 17 serum absorbed with spinal and pharyngeal strains. Serum titrated before and after absorption and tested on M 17 (whole culture) and on M 17 K (variant).

Method.—Equal parts of 20 mg. suspensions and 1 in 50 serum.

Absorbing Strain.	Test on M 17.				Test on M 17K.		
	200	400	800	1,600	200	400	800
Nil	+	+	+	+	+	+	tr.
NP 2	+	+	+	±	+	+	tr.
NP 3	+	+	+	+	—	—	—
NP 5	+	+	+	+	—	—	—
NP 14	+	+	±	tr.	tr.	—	—
NP 67	+	±	±	—	—	—	—
NP 86	+	+	tr.	—	tr.	—	—
M 9	+	+	±	—	+	+	—
M 48	+	+	+	tr.	+	+	—
M 42	+	+	+	±	+	+	tr.

mixture of the 12 non-absorbing strains and did not agglutinate as well as most of the individual cultures.

In Table XXIV the culture used to test the result of absorption was from M 17 K before the last plating, and agglutinated better than the whole culture. Certain pharyngeal strains have

TABLE XXIV.

M 17 serum absorbed with nine naso-pharyngeal strains. Serum titrated before and after absorption and tested on M 17 (whole culture) and on M 17 K (variant).

Method.—Unheated suspensions of 20 mg. per c.c. added to 1 in 10 serum at intervals until final proportions were 19 mg. of culture per c.c. of 1 in 100 serum.

Absorbing Strain.	Test on M 17 (Whole Culture).			Test on M 17K.		
	200	400	800	200	400	800
Nil	+	+	tr.	+	+	+
M 17	—	—	—	—	—	—
NP 4	+	tr.	—	—	—	—
NP 5	—	—	—	—	—	—
NP 11	+	±	—	tr.	—	—
NP 17	+	tr.	—	—	—	—
NP 65	tr.	—	—	—	—	—
NP 67	+	tr.	—	—	—	—
NP 71	+	tr.	—	—	—	—
NP 77	+	±	—	+	+	tr.
NP 86	+	±	—	—	—	—

exhausted the serum of the agglutinin for the variant but not for the whole culture. In addition, two strains, NP 5 and NP 65, have reduced the agglutinin for the whole culture to

below 1-200. This shows the affect of repeated additions of culture in increasing the amount of absorption. Much larger quantities of these two cultures were less effective in a single or even in two applications.

To sum up, these results show that the variant of the strain M 17 shows the same capacity for absorbing an agglutinin in M 17 serum as do the pharyngeal strains, NP 3, 4, 5, 11, 17, 65, 67, 71 and 86, and that this agglutinin is different from the predominating agglutinin for the original M 17 since these pharyngeal strains do not remove the latter.

The following variations were observed incidentally in other strains.

A strain of M 6, already referred to, was obtained which had completely lost its early features, namely, the agglutinability towards M 1 serum and the capacity to absorb the agglutinin. On returning to earlier stock cultures on egg, it was found that these had undergone no change. As this is an isolated example of so marked an alteration, I merely record it.

M 16 at first absorbed partially Group I sera (A agglutinin). Later, as shown, it failed to absorb.

M 43, as related in another place, was resolved into two components; when combined these exhausted the serum produced by the whole culture, though each separately removed only a portion of the agglutinin.

M 12 showed a marked quantitative alteration in absorptive capacity towards M 17 serum. At first 2 mg. of culture in the form of a heated suspension exhausted 1 c.c. of 1-50 dilution. Later two and a half tubes of fresh culture were added to 4 c.c. of 1-50, and the absorbed serum was tested on M 12, the absorbing strain, and on M 17, the homologous. The reduction for the latter was from 1-800 to 1-400. To the 3 c.c. of serum remaining two more tubes of M 12 culture were added; agglutination of M 12 still occurred. After this second absorption the test on the absorbing strain and on the homologous culture showed that the serum was exhausted. The change in quantity of culture required for absorption of agglutinin for M 12 itself may be explained by the culture being hypersensitive although it did not agglutinate with normal rabbit serum in 1-25.

M 41 became towards M 10 serum similarly hypersensitive though not auto-agglutinating, and a large quantity of culture was required to remove the agglutinin for itself.

The above alterations in absorptive capacity of M 12 and M 41 recall the alteration in M 17 which led to the discovery of a variant differing qualitatively in absorptive capacity from the whole culture. Reference has been made in a previous part of this report to the possibility of slight differences in structure between two antigens so influencing the combining qualities of the agglutinins they produce as to lead to an apparently great divergence in the serological reactions of the strains containing them. There is little doubt that if a serum had been prepared with the variant of M 17 the whole culture of M 17 would have absorbed the homologous agglutinin, in consequence of the presence therein of the variant. In that case the relationship, for example, of NP 40 to M 15 would have been reproduced. That is to say,

NP 40 (cf. M 17) would absorb the homologous agglutinin of M 15 (cf. M 17 K) serum, but M 15 (cf. M 17 K) would be unable to absorb the homologous agglutinin of NP 40 (cf. M 17) serum.

A few of the many examples of this relationship between two strains may be recapitulated:—

M 15 absorbed NP 41 serum, but NP 41 could not completely absorb M 15 serum.

M 17 absorbed NP 11 serum, but NP 11 could not completely absorb M 17 serum.

M 10 absorbed M 15 serum, but M 15 could not completely absorb M 10 serum.

M 43 absorbed M 17 serum, but M 17 could not completely absorb M 43 serum.

These observations were referred to in suggesting an explanation for an anomalous result in connection with the absorption of the three agglutinins of Group I (p. 74). It was found that M 10 and M 12 absorbed the homologous agglutinin from M 15 serum, *i.e.*, C agglutinin, but M 12 could not absorb the agglutinin contained in M 10 serum, which agglutinated M 15. Those portions of the antigenic substances in M 10 and M 12 which combine with the agglutinin for M 15 may be assumed to stand in the same relation to each other as the antigens in M 17 and M 17 K.

Serological characters of spinal strains in relation to age of patient.

Information concerning the ages of the meningitis patients, from whom the 66 spinal strains under investigation have been obtained, was available in the case of 55 strains.

	Total.	Group I.	Group II.
Patients under 12 years ...	38	15	23
Patients over 12 years	17	10	7

In the 15 Group I strains from children under 12 years are included the two aberrant strains, M 16 and M 46.

Although the data are insufficient for any general conclusion to be drawn from them, there is evidently a definite preponderance of Group II strains over the commoner varieties of Group I in a series of strains obtained from meningitis in children under 12 years. In patients over 12, on the other hand, the Group I strains are found rather more frequently.

The disproportion is more marked in infants; of 14 cases under 1 year (included in the above 38) 10 yielded Group II strains and 4 Group I (including one aberrant strain). A similar though even greater preponderance of Group II was found in the naso-pharyngeal series of meningococci from persons of all ages. Thus the meningococci found in the cerebro-spinal fluid of meningitis in the most susceptible individuals tend to approximate in character to those in the naso-pharynx of the general population.

Classification of Meningococci by Serological Tests.

This investigation of cerebro-spinal and naso-pharyngeal meningococci has shown that there is no group of naso-pharyngeal cocci which, though identical morphologically and culturally with meningococci, possesses specifically distinct serological characters.

Considering the results of the tests upon the whole series, it has been found that agglutinating sera prepared with certain spinal strains divide the greater part of the series into two groups, the remaining strains being less well defined both in agglutinability and absorptive capacity, in relation to these two groups. The strains which fail to conform to the division into groups are more frequently of naso-pharyngeal than of cerebro-spinal origin.

On examining my results in relation to the age of the patients, I find that meningococcal strains obtained from young subjects, particularly infants but also in the case of older children, resemble the naso-pharyngeal strains of non-contacts in two respects; (1) they yield a higher proportion which is not amenable to group differentiation than do the strains obtained from the disease in adults; (2) they also yield a higher proportion of Group II strains compared with adults. It is quite possible that the more virulent meningococci, *i.e.*, the strains usually found responsible for the disease in the older and less susceptible elements of the population, are those which conform fully to the two main groups in serological characters, and that divergence from these characters is correlated with less virulence, *i.e.*, feebler capacity for invading the system from the naso-pharynx.

But apart from the above broad distinction there has not been shown any possibility of estimating degrees of virulence from serological reactions, and the question is complicated by the differences in individual susceptibility.

It has been found by Gordon, who obtained his material mainly from the military population, that the serological characters of his spinal strains showed uniformity of type. This difference in the source of material may, to some extent, explain why his results do not agree with mine. The cerebro-spinal strains studied in my report have been obtained almost entirely from the civil population and include a large proportion from cases of meningitis in children.

Two instances given in the present report of cultures obtained from post-basal meningitis in infants may be mentioned in illustration. They showed as marked divergence in serological characters from the two main groups as any strain from the naso-pharyngeal series. Both strains agglutinated slightly with sera of Group II; one, M 46, produced a serum which agglutinated mainly Group I strains and the other, M 55, a serum which influenced only itself to any extent. I hope to show later the position in relation to the two main groups occupied by these strains which differ serologically from the commoner and presumably more virulent spinal strains.

In this connection, as showing that the possibility of these differences existing had been recognised, the Report of the Special Advisory Committee* may be quoted. "It must be observed, however, that the strains studied have been epidemic strains from the meninges. It is possible that the meningococci found in the posterior basic meningitis of infants in non-epidemic times will prove to belong to other types and the same seems likely to be true of many of the meningococci found in carriers." The Medical Research Committee's Report

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* Medical Research Committee. Report upon Bacteriological Studies of Cerebro-spinal Fever during the Epidemic of 1915.

says further, with regard to the influence of age on the incidence of the disease:—"It is well known that the sporadic form of cerebro-spinal fever as seen amongst the civilian population is mainly a disease of infancy and early childhood. It becomes rarer in adolescence and is uncommon in adults."

The above expression of opinion was foreshadowed by Arkwright* in 1909, as the following quotation shows. "One feature of the group of meningococci from sporadic cases taken as a whole appears to be that its members are more frequently found to deviate from the type to which most strains conform than is the case with the epidemic group."

Differences in susceptibility may account for the discovery of strains from meningitis in adults which would be classed on the above principles amongst the least virulent. Such strains however have been relatively uncommon, and it is evident that criteria for the identification of the meningococcus which are based on the serological reactions of meningococci occurring most frequently in adults may exclude strains capable of causing meningitis in children.

The adoption of excessively rigorous standards, which can perhaps be justified as a measure of control in the early stages of an outbreak of cerebro-spinal fever, may explain why Gordon and his fellow-workers† have classified the gram-negative cocci of the naso-pharynx in a way which I am unable to regard as correct.

The general consensus of opinion is in agreement with the above statement that the meningococci concerned in the recent prevalence of cerebro-spinal fever show a well marked differentiation by simple agglutination tests into two main groups, a variable number remaining which cannot definitely be placed.

Gordon, however, claims to demonstrate four specific types by means of absorption tests, but differences in absorptive capacity, however well marked, cannot in themselves be taken to be proof of specific differences. I have been able to show that two strains from the same culture may exhibit differences in absorptive capacity which would, according to Gordon's method of classification, resolve them into separate species. Gordon indeed recognises an affinity between his Types 1 and 3, and more recently between Types 2 and 4 also, and in his final conclusion states that it must not be assumed that the limit of their individual variation has yet been defined. Possibly he will discover a still closer relationship in the future. In one of his earlier reports‡ he mentions that a strain absorbed the specific agglutinin from sera of Types 1 and 3 and was therefore labelled amphoteric. It seems to me impossible to justify the specific differentiation of two varieties thus linked together.

Reference should also be made to the work of Colebrook and Tanner§ who have discussed the carrier problem and have come to the conclusion that most carrier strains are true meningococci. In considering their reasons for adopting this view they discuss two hypotheses to account for the apparent inability of the majority of such strains to determine general infections:—(1) most carriers and normal persons possess an adequate natural immunity against the meningococcus, (2) the pharyngeal coccus of the carrier is an attenuated strain incapable of determining a meningitis. While not coming to any final conclusion as to which of the alternative hypotheses is preferable, they apparently consider attenuation of virulence to be an important factor.

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* Journ. of Hyg. Vol. 9.

† Bacteriological Studies, etc.: Special Report Series, No. 3. Medical Research Committee.

‡ Identification of the Meningococcus, Journal of Royal Army Medical Corps, October, 1915.

§ Journal of the Royal Army Medical Corps, January, 1916.

A study of the agglutinogenic properties of these irregular and apparently less virulent strains has shown that the sera prepared from certain of them pick out other members of the class in an irregular fashion, and that therefore these strains are not all identical in antigenic capacities. Such sera agglutinate also the presumably more virulent strains which conform to the reactions of the two main groups, thus demonstrating that the strains producing them are antigenically related to the latter. They agglutinate however strains in both groups more or less equally, a result which apparently invalidates the grouping obtained with the standard spinal sera.

Evidently therefore there is some difference between the Group I and II antigens contained in the typical strains and the related antigens in the less well defined strains, e.g., the latter may not be affected by an antibody in the sera of the former but nevertheless produce antibodies which have a marked action upon corresponding antigens in the former,

Analogous differences, not revealed by simple agglutination tests, have been demonstrated between the antigens of the typical Group I strains and also between those of Group II. For example, two antigens may combine with, i.e., absorb, the same agglutinin though one antigen does not combine with the agglutinin produced by the other.

When it is recalled that variations in antigenic capacity of a similar nature may occur in a strain during sub-cultivation, it is reasonable to assume that the meningococcus antigens are not precisely fixed or stable substances, but are liable to modification under the influence of environment.

I regard therefore these cerebro-spinal and naso-pharyngeal strains which I have investigated as forming a single species, the meningococcus species, which includes two well defined serological races linked together by less highly differentiated strains. This tendency for a bacterial species to differentiate itself into races may be regarded as a continuation of the same evolutionary process whereby bacteria with the characteristics of a common genus exhibit emergence into a greater or smaller number of species.

The views expressed by Andrewes and Horder (*Lancet*, 1906, ii, p. 711), on the classification of organisms into different species may be usefully applied to racial differences between different strains of meningococci.

"When any arbitrary set of characters is taken as a basis for the classification of a group of natural objects the same phenomena are usually seen—large groups of like objects connected by small groups which differ from them in one or two particulars. If the numerical frequency of each individual like group is represented by the proportional height of a vertical line and the lines are arranged in series, the commoner types stand out boldly above the rarer ones. Only in nature they are plotted out, not in linear series, but in space of two dimensions, as it were, so that the common types stand out as mountain tops above their fellows, each mountain connected by valleys of intermediate types with many of its neighbours. If now the mountains were cut off by a horizontal plane half-way up their sides and attention were paid only to the mountain tops, disregarding the valleys, we should have the popular conception of species."

Similarly in the two series of meningococcal strains the two serological groups stand out above the mass of undifferentiated strains.

As mentioned above, these two groups are not fixed types but may be further sub-divided by means of absorption tests into sub-groups which are probably "centres of variation" in the different stages of evolution of the meningococcus antigens. Such variations in the serological properties of antigens must ultimately depend upon changes in their chemical constitution.

Andrewes, in his Presidential Address, The Nature and Degree of Specific Differences amongst Bacteria*, discussing the importance of chemical evolution in determining the formation of bacterial species, says :—"Only now do we begin to get a hint of what I believe to have formed a large part of the course of evolution within the morphological boundaries of bacterial genera—namely, that it has been a chemical rather than a structural one—a change not so much in the configuration of the organism as in that of the protein molecules which build it up." (This conception can, I think, be applied to the evolution of racial types within a species just as much as to the evolution of different species). "But just as in the building up of higher organisms many proteins are concerned so, though perhaps in a lesser degree of complexity, must the bacterial body be built up of several kinds of protein, in varying combination, some perhaps peculiar to the species others common to many."

And with reference to racial differences of meningococci the Medical Research Committee's Report says :—"The races are defined by methods the relative values of which may still be disputed and the differences brought out by these methods may be conjectured to depend upon slight changes in the atom groupings of the bacterial protein determining its reaction with a particular antibody."

Although the validity of the sub-division of the two main groups of meningococci into types upon the results of absorption tests is open to question, there is no doubt as to the importance of such serological tests in furnishing information on the relationship of antigens in different strains. The possibility of the differences in antigenic capacity being correlated with differences in virulence makes their detailed study of more than academic interest.

My observations on the serological and biochemical reactions of the meningococcus have brought me to the conclusion that the meningococcus antigen is composed of two different proteins and it is the relative proportions of these in one strain which decide its position in relation to the two main groups. The further division into sub-groups and atypical strains must on this hypothesis be due to alterations in the configuration of the two specific proteins.

It is probable that the changes in the atom groupings are not haphazard but follow a definite tendency. My results seem to show that in the case of the meningococcus antigens they are in the direction of increased or diminished complexity of structure of the receptor apparatus, with corresponding increase or diminution in the range of combining capacity. This inference is based upon a comparison of the absorptive capacities of strains for the agglutinins contained in different sera.

In the annexed scheme, which is intended to represent graphically evolution of antigenic complexity, I have commenced with a hypothetical complete meningococcus antigen possessing the full antigenic capacities of Group I and Group II.

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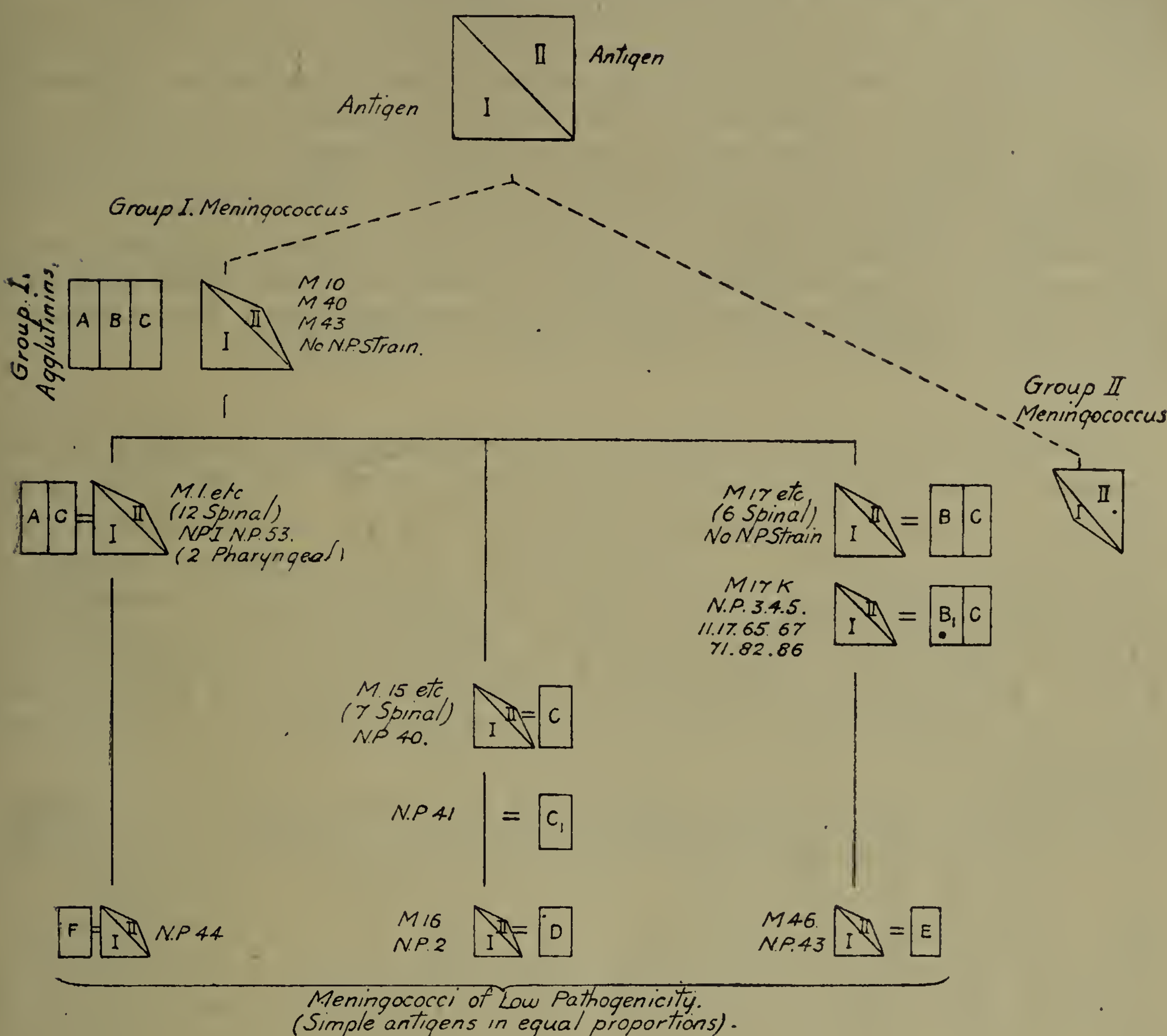
* Proceedings of the Royal Society of Medicine, 1913, Vol. VII. (Pathological Section).

Epidemic Meningococcus (Complex antigens in equal proportions).



The actual existence of such strains has not been demonstrated but is at least suggested by the following considerations. In the severe epidemic of cerebro-spinal fever in Silesia during the winter of 1904–1905, the strains of meningococci tested by Lingelsheim all reacted with monovalent agglutinating sera prepared with one of them. The majority of the strains were cultures from the naso-pharynx. It may be argued that Lingelsheim was dealing with only one of the two groups. Against this are his observations that all his strains produced strong and equal fermentation with dextrose and maltose contained in his solid media. There is certainly a possibility, though at the present day no final conclusion can be reached, that his strains each possessed the complete antigenic properties of both groups. It is of interest to note that in subsequent German investigations during the years 1906-1909 (see Dr. Eastwood's Report*) cerebro-spinal strains were found which exhibited less uniformity in agglutination and fermentation reactions ; also aberrant strains were found in the naso-pharynx. It is possible that strains with double antigenic properties such as Lingelsheim may have been dealing with were relatively unstable and capable of being easily resolved into two less complex components with one or other antigen in predominance. An observation by Dr. Scott may be quoted in this connection ; he obtained from a single culture two strains, one with Group I characters and the other with Group II.

In their bearing on this question the results of Walker Hall and Peters† are

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* Reports to the Local Government Board (New Series), No. 110, 1916.

† Changes in the Agglutinability, Fermentation Reactions and Absorptive Capacities of the Meningococcus during the Acute Attack. Journal of the Royal Army Medical Corps, October, 1916.

also suggestive. They adopted the plan of comparing the serological reactions of meningococci obtained from the same patient on successive days. In two cases of severe cerebro-spinal fever they found differences. The second of these, recorded at the end of their report, may be quoted as an example. The meningococcus recovered from the cerebro-spinal fluid on the third day absorbed Type 2 agglutinins, while that recovered on the fourth day absorbed agglutinins of both Types 1 and 2. It might be suggested that the injection of Dopter's serum after the first withdrawal of fluid had some influence in producing this apparent alteration. Assuming the presence of two components in the spinal fluid, Dopter's serum would reduce the Type 2 cocci and there would be increased probability of isolating a strain containing Type 1 cocci. The work of these authors is of particular interest to me in furnishing as it does some experimental evidence of a virulent strain with double antigenic properties, and I agree with them that "some aspects of the problems associated with the grouping of meningococci may be solved by further study on similar lines."

But, though possibly with rare exceptions, the antigens of the strains found in the present epidemic were less complex and commonly showed a preponderance of I or of II; these are figured in the scheme as descendants of the primary antigens.

A particular study was made of spinal strains containing Group I antigen and related strains from the naso-pharynx, and I have attempted to represent in the remainder of the scheme the plan upon which these various strains appear to be linked together.

Following the genealogical table downwards a triangle represents the antigen and an oblong the agglutinin with which it is capable of combining, and diminution in complexity of these substances is indicated by decrease in size of the figures. Thus the three most complex antigens of Group I are contained in M 10, 40 and 43, which can bind all three agglutinins A, B and C of Group I; no strain of equal complexity was found in the naso-pharynx. One of these complex strains, M 43, was resolved into two daughter strains, equivalent respectively in serological characteristics to M 1 and M 17; each of them was capable of binding two agglutinins but neither was of sufficient antigenic complexity to bind all three.

Comparing spinal with pharyngeal strains, two pharyngeal strains were found which absorbed the two agglutinins A and C, but none was quite equal to M 17 in absorbing B and C agglutinins. There were 7 spinal strains and 1 pharyngeal strain of still simpler antigenic structure which combined only with C agglutinin.

According to Andrewes and Horder's simile, these three sub-groups of Group I, of which M 1, 15 and 17 are types, would stand out as mountain tops united in the valleys by the undifferentiated spinal and pharyngeal strains such as M 16 and 46, and NP 2, 43 and 44, which can only with difficulty be identified with any other strain. These intermediate types in the valleys, to use their words, illustrate variation and the connexion between allied species (here serological races).

The analysis of Group I antigen, and the demonstration of its association with Group II serve to explain (*a*) different range of valency of different Group I sera and (*b*) action of naso-pharyngeal sera on cerebro-spinal strains, in the following way.

I have represented in the scheme every strain as containing a small portion of Group II antigen in addition to the main

antigen of Group I. It will be seen that in the undifferentiated strains the two antigenic substances become proportionately equal and the Group II portion has become of greater relative importance than in the more complex strains. This relationship is reflected in their antigenic capacities, since many produce sera which agglutinate more or less equally strains in the two well defined groups. These latter strains, although they may be well agglutinated by such naso-pharyngeal sera, do not readily absorb the homologous agglutinins, and it has been observed that a mixture of strains of the two groups may be more efficacious in absorbing than strains of either group alone. In the case of the more complex strains on the other hand, e.g., M 10 and M 43, the Group II antigen is quantitatively of slight importance, and in the process of immunisation the antibodies are produced against the most prominent antigen. Thus one obtains a serum the agglutinating action of which is largely confined to those strains containing mainly Group I antigen.

In regard to the production of acid in the presence of glucose and maltose it has been found that strains which produce agglutinins mainly of one group generally produce more acid with one sugar than with the other; the fermentation of glucose is associated with the formation of Group II agglutinins, and the fermentation of maltose with the agglutinins of Group I. On the other hand the atypical strains, which have been assumed to contain a simple form of each antigen in about the same relative proportions, often ferment both sugars equally. It has been observed that the latter strains adapt themselves with greater difficulty than the typical strains to growing on glucose agar without added serum.

Following the genealogical table from below upwards and adapting the above considerations to Andrewes and Horder's hypothesis, the sub-groups of Group I, as well as the less well defined Group II, would be types emerging from a mass of undifferentiated forms, and they would owe their greater frequency of occurrence in cerebro-spinal fluid to being more fitted for invasion by chemical adaptation. This adaptation is represented as due to progressive increase in complexity of structure and I have indicated that this progression may be continued until a strain is evolved which is equally well equipped with the complete Group I and Group II receptors. This I have shown by figuring a hypothetical strain in which both the meningococcus antigens are in equal proportions and of maximum complexity. The introduction into the community, from within or without, of a strain approximating to such a prototype might explain the origin of an epidemic of cerebro-spinal fever.

An epidemic meningococcus of such high complexity would not be stable but would undergo degeneration with rapidity proportional to the resistance it met and would retrace its steps along the path of evolution, giving rise on the way to the two main groups and to the various sub-groups of diminishing complexity. It would end again where it arose in the mass of undifferentiated forms with relatively slight capacity for invading the body from their habitat in the naso-pharynx.

There are thus two conceptions, (1) the slow upward development of complex virulent types, (2) the more rapid devolution or degeneration into simple less virulent types. Both of these

processes are likely to take place in the course of an epidemic and may to some extent go on simultaneously.

It will be of interest to examine the evidence available of the serological characters of the meningococci obtained in the early period of the epidemic on Salisbury Plain. Ellis* found his Type I eight times and Type II three times. Arkwright* reported on nine cases from the First Canadian Contingent on Salisbury Plain; five belonged to the "meningococcus" group and two to the "parameningococcus" group (the former corresponds to Type I of Ellis and Group I of this report); one, Chandler, agglutinated slightly with sera of both groups and the remaining strain, Chase, fell in different groups on two occasions. Arkwright concluded that Chandler probably belonged to his meningococcus group and that Chase perhaps contained individual cocci which reacted with different sera. Gordon†, working with 32 strains from various sources, classified 23 in Types 1 and 3 (apparently related in simple agglutinability and probably corresponding to Group I of this report) and 8 in Type 2, the remaining one not conforming to any of the three types.

It is clear that the two serological races were already well defined early in 1915, and there seems little doubt that strains containing Group I antigen were most conspicuous at the commencement of the epidemic. If the results recorded in this report, which deals with strains collected at a later stage of the outbreak, are contrasted with the above, it will be seen that meningococci of Group II have been obtained from the cerebro-spinal fluid rather more frequently than those of Group I. The various strains investigated were obtained from different parts of the country and their collection was not begun until towards the end of March, 1915.

My strains include many from cases of meningitis in children, and the results are therefore not strictly comparable with those quoted above. The experience of the workers for the military authorities has however been similar, as the following quotation from Lieutenant-Colonel Gordon's report‡ shows:—"The meningococci coming from military cases during 1915 were chiefly specimens of type 1 at first, but as the outbreak progressed, type 2 became more abundant. When the disease declined, during the summer of 1915, several specimens of type 3 were met with; and the solitary specimen of type 4 also dated from the later stages of this 1915 outbreak. It was noteworthy that when the disease returned in the last months of 1915, first of all type 1 reappeared, to be shortly succeeded by type 2, which then became the predominant type. The epidemic of 1916, however, has also been remarkable for an increase in the number of cases due to type 4."

Gordon summarises the meningococci from cases during 1916 as follows:—

Type	1	...	2	...	3	...	4
Specimens ...	64	...	69	...	6	...	18

In comment on the above summary, I may point out that types 1 and 3 give a total of 70, and types 2 and 4 a total of 87. The former, 70 specimens, I regard as Group I, and the latter, 87 specimens, as Group II.

Apparently the meningococci responsible for sporadic cases and small outbreaks prior to the year 1914 were not so well defined in their serological characters as those obtained subsequently.

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* British Medical Journal, 1915, vol. II, pp. 881 and 885.
† Gordon and Murray (1915). Journal R.A.M. Corps., vol. 25, p. 411.
‡ Special Report Series, No. 3, p. 16–18.

In reference to the epidemic of 1914–1915, the Medical Research Committee's Report says: "The reports from the Salisbury Plain area suggest not indeed that the Canadians imported a new disease into this country, for we have always had it with us in sporadic form, but that they did introduce a virulent strain of meningococcus and were in some degree responsible for its spread."

If the results of recent serological work in this country are compared with past records, the above suggestion finds some support. Arkwright (1909)* foreshadowed the division of meningococci into serological groups but his groups were not well defined nor limited to two. In his work on the epidemic of 1915 on the other hand, he found that only 5 out of 35 spinal strains failed to conform to one or other of two groups. Ellis during the same period was similarly successful in allotting his strains to two groups, and the work in this laboratory had a like result. Gordon† in his previous work on the agglutination reactions of the meningococcus (1907) failed to find them of any value in the identification of the meningococcus. But recently he, like the above authors, readily identified two main groups into which 80 per cent. of his spinal strains fell.

It would be interesting to know if there had been a similar correlation between the types of meningococci in the naso-pharynx at these different periods.

There is unfortunately no information as regards the distribution of the meningococcus in the naso-pharynx of people in this country prior to the recent epidemic. Arkwright in his early investigation of contacts on Salisbury Plain did not find the meningococcus at all wide spread:—4 positives out of 349 naso-pharyngeal examinations of contacts. The investigation of non-contacts conducted in the Board's Laboratory showed that during the month of April, 1915, meningococci were numerous in the throats of a section of the London population. Whether this result represented the normal seasonal incidence or was a special circumstance related to the epidemic prevalence cannot now be determined. As regards the serological characters of the pharyngeal meningococci of non-contacts, it has been found that the standard Group II sera agglutinate many more pharyngeal strains than the Group I sera and that the Group II antigens of the pharyngeal strains can be more readily identified with the similar antigens in the spinal strains than can the pharyngeal Group I antigens.

As an interesting parallel to the evolution of epidemic meningococci, the results of an investigation by Seligmann‡ on the bacteriology of dysentery in the German army may be quoted. He observed that at the height of the disease in 1915 and again in the following year the strains of dysentery isolated were almost exclusively typical, and it was only towards the decline of the epidemic in each season that the atypical forms made their appearance. Discovering at the end of the epidemic of 1915 that carriers of dysentery bacilli were rare, he determined, on the recurrence of the disease in 1916, to study the strains from the very earliest cases. His assumption was that if epidemic strains developed anew under the influence of climatic and other factors, the earliest strains would include amongst them undeveloped intermediate forms. He tested the suspicious strains from the first 34 cases as to their relationship to dysentery bacilli, and he found a considerable number of these diverged more or less from the recognised types; of the remainder, five were readily classed as typical Shiga and nine as Flexner bacilli. The results supported his original hypothesis, and in addition he was able to arrange the strains in such

* Journal of Hygiene, vol. 9.

† Report to the Local Government Board, 1907.

‡ Cent. f. Bakt. Orig. Bd. 79, Heft. 2, p. 71.

a way as to give a strong impression of stages in the evolution of the types of dysentery bacilli. The series was as follows:—

(1) A gas-forming bacillus related to B. coli.
(2) Inagglutinable bacilli of the Flexner group without appreciable antigenic properties.
(3) Poorly agglutinable Flexner bacilli, possessing highly specific and individual antigens.
(4) Poorly agglutinable Flexner strains, the antigenic capacities of which closely resembled the normal Flexner type.
(5) Typical Flexner bacilli.
(6) Strains (Doppelstämme) which were agglutinated by both Flexner and Shiga sera and produced specialised sera showing relationship to (4).
(7) Poorly agglutinable Shiga-Kruse strains.
(8) Typical Shiga-Kruse bacilli.

The author noted that there were many gaps, notably between Groups 1 and 2 and between Groups 6 and 7.

There are certain analogous features in the serological reactions of meningococci and dysentery bacilli. In both species there are two well-defined groups and a number of strains which exhibit characteristics of both groups. In the case of the meningococcus some of the latter strains have not only the agglutinability of both groups but also the agglutinogenic capacities. Dysentery strains corresponding to these would occupy the gap between (6) and (7) in Seligmann's series.

It seems to me difficult to conceive the typical Flexner antigen changing into the typical Shiga antigen. I should prefer to consider the intermediate strains as possessing simple forms of both Shiga and Flexner antigens, one or other of which by a process of chemical adaptation may develop greater complexity. Evolution thus takes place along two different lines, resulting in the formation of typical bacilli either of the Shiga or of the Flexner type.

Two alternative explanations of emergence of types in connection with the recent epidemic of cerebro-spinal fever may be discussed.

(1) Emergence occurred in one focus only, with subsequent spread and confusion with indigenous strains. The suggestion that a virulent strain was introduced into the country has been referred to. According to the scheme on p. 99 this meningococcus might be represented either as approximating to the hypothetically complete epidemic strain with both antigens in equal proportions and of equal complexity or as a strain less completely equipped but with the Group I component more developed than the Group II. On the latter assumption this strain, being alterable in type, might in its passage from naso-pharynx to naso-pharynx become resolved into two less complex strains, one with the Group I antigen in excess and the other with the Group II. The greater complexity of the former antigen would result in the greater range of variation which has been shown by strains of Group I. On the other hand the simpler form of Group II antigen would explain the occurrence of the large number of sub-groups in both the spinal and the naso-pharyngeal series of apparently equal complexity. The frequent occurrence of the typical Group I strains in the spinal fluid compared with their comparative rarity in the naso-pharynx would be accounted for on the assumption that they were more adapted for invading the

body in virtue of the possession of the more highly developed antigen.

This higher virulence however, is only relative, as the following considerations show. Three of the more complex Group I strains were found in the naso-pharynx of the 700 non-contacts examined. Since the incidence of cerebro-spinal fever in 1915 was ·07 per 1,000 of the general population of England and Wales and approximately half the cases would be due to Group I strains, it is obvious that the most virulent strains produce cerebro-spinal fever in a very small minority of the persons carrying such organisms in their throats.

The above hypothesis carries with it the assumption that carrier strains of meningococci spread throughout the country from a primary focus on Salisbury Plain, and that the different serological races are less complex variants of the original epidemic strain. One difficulty in supporting this hypothesis is that the existence of this complex epidemic strain though suggested has not actually been demonstrated.

(2) Emergence occurred by evolution in more than one focus. The Medical Research Committee's Report discusses the conception that in an epidemic of cerebro-spinal fever there may be a saprophytic spread of individual races which have attained greater virulence side by side with the domestic and relatively harmless strains indigenous to the locality. In this case evolution takes place along different lines, and one has to imagine some influence in action which sets in motion the process at a number of foci.

In the earliest serological investigations made during this epidemic Ellis* found both types represented in every epidemic focus he investigated and Arkwright* found no support for the view that the meningococci concerned in a particular outbreak were limited to one group. Such distribution may indicate that the two types were evolved simultaneously in the several foci; it is however equally consistent with a possible spread of both from a single focus.

The final decision between (1) and (2) rests probably with epidemiology, but the above evidence brought forward on the variations in the serological characters of the organisms concerned may perhaps be of some assistance.

Further light may be thrown on these questions in the future when an epidemic occurs after a period during which the disease has only exhibited sporadic manifestations. In the meantime it will be interesting to study, as the present prevalence of cerebro-spinal fever gradually diminishes, the changes taking place in the serological characters of the strains of meningococci concerned. And, in the light of the evolutionary possibilities suggested by Seligmann in the case of dysentery bacilli and enunciated in more general terms by Andrewes and Horder, who consider that different species may still be in process of emergence from the same genus, one might speculate on the relationship to the meningococcus group of the naso-pharyngeal organism which cannot be accepted as a meningococcus but differs culturally from the true meningococcus only in the marked production

* British Medical Journal, 1915, vol. II.

of pigment. The few strains of this character which I examined exhibited no serological relationship to true meningococci. According to one's point of view, such strains might be considered as the possible starting point or the possible end point in the process of evolution of the meningococcus.

Summary and Conclusions.

The serological characters of 66 strains of meningococci obtained from the cerebro-spinal fluid in cases of meningitis have been studied. Serological tests of a similar nature have been applied to 86 strains of gram-negative cocci, culturally identical with meningococci, obtained from the naso-pharynx of non-contacts. The two series have been compared in respect of agglutinability, agglutinogenic capacity, and absorptive capacity with the following results:—

The majority of the spinal strains can be divided into two main groups by simple agglutination tests with selected spinal sera: about 27 can be assigned to Group I and 34 to Group II, the remaining 5 being relatively inagglutinable or equally agglutinated by sera of both groups.

If the naso-pharyngeal strains are grouped on the same principle, that is, according to the height of titre and consistency of reaction in the presence of the same standard group sera, 2 or 3 would be classed as Group I and about 50 as Group II; the remainder could not be classed on account of inagglutinability or equal agglutination with sera of both groups.

The naso-pharyngeal strains produce active agglutinating sera for spinal strains. Certain pharyngeal strains, resembling the atypical spinal strains in agglutinability and agglutinogenic capacity, produce sera which agglutinate without distinction spinal strains belonging to separate groups as shown by their agglutination with the standard spinal sera.

The naso-pharyngeal and cerebro-spinal strains which are agglutinated by Group II sera absorb the homologous agglutinin from those sera with equal readiness. On the other hand, the typical Group I sera are less readily and completely absorbed by the pharyngeal than by the spinal strains agglutinated by them. This difference has been found to be dependent upon variations in complexity of structure of the Group I antigen. Similar variations have been shown to occur in typical spinal meningococci during subcultivation.

Stated in general terms, the inter-relationship between spinal and pharyngeal strains is as follows:—

The naso-pharyngeal strains are not serologically separate and distinct from the cerebro-spinal strains, and moreover have not been found to exhibit among themselves such serological differences as would justify the separation of any number of them into a class or classes, identical with each other and distinct from meningococci of cerebro-spinal origin. Consequently I can find no justification for the view that naso-pharyngeal meningococci of the non-contact differ as a class from strains which might

be found within the immediate environment of cases of the disease. The occurrence of such organisms in considerable numbers among the non-contact population, though unexpected, is in accordance with epidemiological experience that the majority of cases of the disease cannot be traced to a previous focus.

The most pronounced of the serological differences which are found between spinal and pharyngeal strains are not greater in degree than the differences between individual spinal strains. Admittedly the meningococci of cerebro-spinal origin which exhibit so great divergence from the majority or the typical, are relatively few, but it is certain that the 66 specimens of cerebro-spinal origin investigated do not exhaust all the possibilities of variation. For this reason, as well as on account of the necessity of preparing an agglutinating serum from each atypical strain, it has not been possible to identify every naso-pharyngeal with a cerebro-spinal, that is, with a meningococcus of proved pathogenicity, but sufficient progress has been made to justify a general statement that the serological differences between the spinal and pharyngeal strains are not of a specific nature.

Although, as I have shown, the two series of meningococci belong to one and the same species, the comparative tests show that while a considerable number of the pharyngeal strains are serologically identical with the majority of the spinal strains, there is a residue in each of the two series, much larger in the case of the pharyngeal, which is not capable of being identified in a complete serological sense with that majority. These residual pharyngeal strains are not identical with each other, but a few of them have been identified with the smaller number of the residual spinal strains.

It may be concluded from the above that a certain proportion of pharyngeal meningococci appear to effect a successful invasion of the meninges with relative infrequency, and there is a reasonable probability that the differential factor is one of virulence. There is thus suggested a correlation between virulence and serological reactions. The serological differences between strains of meningococci have been shown to depend upon variations in complexity of antigens as inferred from differences in range of absorptive capacity. The least complex strains are found more frequently in the naso-pharynx of the non-contact and in the meningitis of infants than in cerebro-spinal fever of adults. It may be concluded that virulence, in the sense of capacity to invade the meninges from the naso-pharynx, runs parallel with antigenic complexity. The most complex strains are the most virulent and occur most frequently at the height of an epidemic.

The less complex antigens do not bind the anti-bodies produced by the more complex. This fact is of obvious practical importance in the selection of strains for the production of therapeutic sera; each of the two group antigens should be represented in the most complex form available.

The naso-pharyngeal strains of gram-negative cocci used in this investigation were selected solely on the grounds of identity

in cultural and fermentation tests with meningococci of cerebro-spinal origin. Since the serological tests have confirmed the relationship of the former organisms to the latter, the conclusion is justified that meningococci form a well-defined species of gram-negative cocci and can be identified in the naso-pharynx by careful application of cultural and fermentation tests.

Addendum.

Since the preparation of the preceding part of the report the serological reactions of a further series of 24 spinal strains have been tested. For seven of the cultures I am indebted to Professor Andrewes. The remaining cultures were obtained from cerebro-spinal fluid of cases of meningitis sent to the Board's Laboratory for diagnosis from various parts of the country during the period from February 28, 1917, to May 5, 1917. The same tests have been applied as were found useful in comparing the antigenic properties of different strains of meningococci in the main report. All the suspensions of the different strains were the same throughout. The results which are summarised in the accompanying table serve to illustrate several of the characteristic features of the inter-relationship between strains of meningococci demonstrated in the report. These will be referred to under the various headings.

A.—Correlation between fermentation reactions and serological tests; the production of acid with maltose is associated with the presence of Group I antigen, and acid production with glucose with the presence of Group II antigen.

B.—Division of spinal strains into two groups by the action of two agglutinating sera prepared with standard spinal strains, M 10 and M 18.

Demarcation of spinal strains into groups disappears when strains are tested with sera made from undifferentiated naso-pharyngeal strains, NP 44 and NP 43.

C.—Group I strains exhibit gradation in antigenic complexity and corresponding variations in absorptive capacity for the agglutinins in Group I sera.

M 69 absorbs homologous agglutinin from three sera: M 10 serum (A agglutinin), M 17 serum (B agglutinin), and M 15 serum (C agglutinin).

M 67, 68, 70, 71 and 72 absorb A and C agglutinins.

M 76 and 79 absorb B and C agglutinins.

M 73, 74, 77, 78 and 75 absorb C agglutinin only, the first four partially and the last, M 75, completely.

M 80 absorbs B agglutinin partially.

D.—Group II strains do not show the same gradation in absorptive capacity as the Group I strains. The majority absorb one or other of the four selected Group II sera, but several, M 86, 87, 88 and 81 fail to absorb any agglutinin completely from these spinal sera.

E.—Spinal strains in both groups may absorb agglutinin from the naso-pharyngeal serum, NP 44.

F.—The strains M 70, 69, 71, 79, 76, 75, 78, 90, 85 and 84 were obtained from a localised outbreak of cerebro-spinal fever at a camp.* Seven belonged to Group I, showing every degree of absorptive capacity previously demonstrated; two absorbed agglutinin from the same Group II serum; one absorbed agglutinin partially from a Group I serum and completely from a Group II serum.

* In respect of the termination of the disease in these cases Dr. Whitley kindly gave me the following information :—

Of the 7 infected with Group I strains, 5 died and 1 recovered ; in 1 the disease has become chronic and the result is yet in doubt.

Of the 3 infected with Group II strains one died and two recovered ; strains with identical serological characters produced in one case a mild disease and in another a fulminating type.

Summary of Fermentation and Serological Reactions of 24 recent Cerebro-spinal Meningococci.

	A	B				C			D				E	
Strain.	Fermentation Reactions.	Simple Agglutination Tests.				Absorption of Group I. sera.			Absorption of Group II. sera.				Absorption of Naso-pharyngeal sera.	Age of patient.
	Maltose Glucose.	Group I. M 10 serum.	GroupII. M 18 serum.	Naso-pharyngeal sera. N.P. 44.	Naso-pharyngeal sera. N.P. 43.	M 10 serum.	M 17 serum.	M 15. serum.	M 18 serum.	M 24 serum.	M 32 serum.	M 33 serum.		
M 67	M. > G	1,600	—	400	400	+	—	Partial	—					
M 68	G = M.	1,600	—	400	800	+	—	+	—				NP 44 partial	Child
M 69	M. > G.	1,600	—	400	200	+	+	+	—					18 years
M 70	M. > G.	1,600	—	800	800	+	—	+	—					18 ,,
M 71	M. > G.	1,600	—	100	—	+	—	+						33 ,,
M 72	G. = M.	800	—	400	200	+	—	+	—				NP 44 +	35 ,,
M 73	M. > G.	1,600	400	100	—	—	—	Partial	—		—	—		17 ,,
M 74		800	—	800	—	—	—	Partial	—					13½ ,,
M 75	M. > G.	800	200	400	200	—	—	+	—					15 ,,
M 76	M. > G.					—	+	+						10 ,,
M 77	M. > G.	400	—	400	400	—	—	Partial	—		—	—		Adult
M 78	M. > G.	400	200	800	800	—	—	Partial	—		trace	trace		18 years
M 79	M. > G.	200	100	200	200	—	+	+						18 ,,
M 80	M. > G.	200	—	400	400	—	Partial	—	—		—	—		Adult
M 81	G. = M.	200	200	1,600	800	—		—	Partial		Partial	—	NP 44 partial	
M 82	G. > M.	—	1,600	800	400	—	—		+		—			
M 83	G. > M.	—	1,600	800	800	—	—	—	+		—	—	NP 44 —	Infant
M 84	G. > M.	—	1,600	1,600	800	—	—		—	—		+		18 years
M 85	G. > M.	—	1,600	200	100	—		—	—	trace	—	+		15½ ,,
M 86	G. > M.	—	800	800	400	—	—	—	—	trace	—	—		2½ ,,
M 87	M. = G.	—	800	400	200	—	—	Partial	Partial		—	—	NP 44 +	23 ,,
M 88	G. > M.	—	400	400	400	—		—	—	Partial	—	—		5 ,,
M 89	M. = G.	—	400	800	800	—	—		—	Partial		+		
M 90	M. > G.	—	100	400	400	—	—	Partial			+	—	NP 43 +	18 ,,

IV.—A further study of the Serological Reactions of Meningococci from the Spinal Fluid and the Naso-pharynx, with special reference to their classification and to the occurrence of the latter among Normal Persons; by W. M. Scott, M.D.

TABLE OF CONTENTS.

INTRODUCTION.

In a previous report* I showed that micro-organisms microscopically and culturally indistinguishable from meningococci of pathogenic origin were present in the naso-pharynx of 30 out of 138 persons (22 per cent.) who had had no demonstrable connection with cases of cerebro-spinal fever. Many of these meningococcus-like organisms were also indistinguishable from known pathogenic strains by serological tests, *i.e.*, they agglutinated like known pathogenic meningococci in high dilutions of anti-meningococcal sera; others, however, failed to react to a decisive extent, resembling in this certain pathogenic strains which also failed to give decisive results with any of the sera applied.

The serological tests recorded in that report showed, in addition, that great differences exist among cerebro-spinal as well as among naso-pharyngeal meningococci in their behaviour towards any one monovalent agglutinating serum, but evidence was brought forward to show that the majority of the known pathogenic meningococci examined could be put serologically into two main groups, the members of each being closely alike and well distinguished from those of the other group. At the same time it was shown that there existed both cerebro-spinal and naso-pharyngeal strains which could not be satisfactorily identified by serological tests with either of these two main groups.

In continuing this investigation I have obtained additional strains for study, both from the spinal fluid of cases of cerebro-spinal fever and from the naso-pharynx of persons not associated with the disease, and I have endeavoured in particular to determine by further serological tests the biological relationships of the aberrant strains mentioned above to each other and to the apparently well-defined main groups. For this purpose I have investigated their agglutinogenic and absorptive capacities, as well as their agglutinability: *i.e.*, I have injected them into rabbits and tested upon both typical and atypical strains the agglutinating properties of the sera so produced, and I have compared aberrant with typical strains as regards their capacities of absorbing agglutinin from various sera.

The material employed for the purpose of this report consists of 60 strains of meningococci cultivated from spinal fluid, including 26 not dealt with in my previous investigation, and 71 strains obtained from the naso-pharynx, the majority from people not suspected of connection with cases of the specific disease, but others from direct contacts. Of these, 55 have been isolated since the completion of my former report. The work has been done in the Board's laboratory, and, as before, in consultation with Drs. Eastwood and Griffith of the Board's pathological staff, to whom I wish again to express my indebtedness. I have also to thank various regimental medical officers for permission to take swabs from men under their care.

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* Reports to the Local Government Board on Public Health and Medical Subjects, N.S., No. 110 (1916).

Origin of the Strains Investigated.

Of the strains of cerebro-spinal origin 21 were isolated by Dr. Arkwright, of the Lister Institute, during the epidemic of 1915: these were partially studied and described in my previous report (loc. cit.), and appear in the present description under the same designations A 1, A 2, etc. Twelve strains I owe to the kindness of Professor Andrewes and Dr. Canti, of St. Bartholomew's Hospital; these were isolated during the latter part of 1916, and with one exception were from infants under seven years. They are designated B 1, B 2, etc.; they are different from the strains from the same source described by Dr. Griffith, except B 12, which is his M 77. Finally, 27 strains were isolated by myself, all but four being from specimens of cerebro-spinal fluid kindly sent me during 1915 and 1916 by Dr. Foord Caiger, of the South-Western Isolation Hospital. These are designated C.S. 1, 2, etc., those described in the former report bearing the same numbers in this.

Naso-pharyngeal Strains.

These are designated N 1, N 2, etc., the numerical order being determined by the alphabetical order of the names of the persons furnishing the strains and by the date on which each batch of swabs was taken. Strains N 1 to N 16 represent the survivors of those isolated in June and July, 1915, from out-patients attending Lambeth Infirmary, and have already been partially described in my former report. The following strains were collected whilst, in my capacity as local Medical Officer of Health, I was co-operating with the military authorities in the control of epidemic disease. Strains N 17 to N 22 were isolated on February 17th, 1916, from soldiers in a garrison town in Kent; N 23 to N 27 were obtained on March 2nd, 1916, from soldiers in huts near a small village on the Kentish coast, while N 43 to N 49 were obtained from another section of the same battalion at this place on May 11th, 1916. None of these had had any known connection with cases of cerebro-spinal fever, but on May 24th, 1916, two cases of the disease occurred in this battalion, and strains N 54 to N 71, isolated on May 26th, 1916, were from contacts occupying the same huts as the two cases. Strains N 28 to N 30 were isolated on March 23rd, 1916, from the personnel of a medical inspection room attached to a battalion in camp in a rural parish in Kent, while strains N 31 to N 42 were taken from soldiers of this battalion on March 28th, 1916. None of these had had any direct connection with cases of cerebro-spinal fever, but a soldier from the battalion developed the disease on March 20th while absent on leave, and there was also a civilian case, a child, on the same date, in a house in which two men from the same body were billeted. No other cases were reported to me among or in connection with these soldiers afterwards.

Finally strains N 50 to N 52 were obtained from one civilian and two military contacts of two cases which occurred in billets on March 20th and April 5th, 1916, in the town of S——, Kent, while strain N 53 was isolated from a soldier, a positive contact

who had been pronounced a chronic carrier by the military authorities concerned.

Among my 71 naso-pharyngeal cases the first 49 strains, N 1 to N 49, are thus derived from non-contacts, while 22, N 50 to N 71, are from contacts; 17 are from civilians, nearly all of adult age, and 54 from soldiers; 16 were isolated during June and July, 1915, and the rest during the first half of 1916.

Morphological and Cultural Characters.

In this connection I have no reason to supplement or modify the details contained in my former report regarding the appearance of colonies on the primary plates; as before, a large proportion of the naso-pharyngeal strains fermented glucose more strongly than maltose; with some, indeed, the fermentation of maltose was extremely feeble on first isolation.

Agglutination Tests.

Sera employed.

As before, monovalent sera alone have been employed, all from rabbits. 19 strains altogether have been used for their preparation, and the sera produced are designated by the same symbols as the strain injected. 2 were prepared by injection of presumed pathogenic meningococci from the naso-pharynx of acute cases of cerebro-spinal fever. Of these P 1 is the strain which produced the serum "Boscombe" referred to in my former report, while P 2 is "Clayton." 9 were prepared with strains of cerebro-spinal origin, and are known by the corresponding titles, C.S. 8, C.S. 14, C.S. 16, C.S. 20, A 2, A 10, A 13, A 17, A 24. Of these strains C.S. 8 and A 2 were used in producing the sera of the former report named "Smith" and "Chandler."

Eight naso-pharyngeal strains from non-contacts were employed, and the respective sera are entitled N 1, N 2, N 7, N 10, N 13, N 19, N 29, N 48.

With all but 1 of these 19 strains I obtained sera agglutinating the homologous coccus completely in dilution of 1-1,000 or over; in the case of strain N 7, in spite of prolonged immunisation, the titre failed to surpass 1-800. In this strain abnormal toxicity of the culture caused the death of several rabbits during immunisation, so that a satisfactory serum was not produced; this was the case also with several other strains, both naso-pharyngeal and spinal, the sera obtained being of too low titre for use.

Technique of preparation of sera.

Antigens.—The bacterial growth was obtained from slopes of Kutscher's medium or glucose-ascitic agar of 24 hours' incubation, and was injected intravenously while still alive and fresh. The dose employed was increased during immunisation from half a slope to two slopes. In the case of the more "toxic" strains on first injection even a loopful of growth, say 10 mg., was fatal within 48 hours. In some cases the bacterial growth

from 24 hour egg slopes was used, but the progress of immunisation was unsatisfactory and eventually in all cases Kutscher or glucose-ascitic agar was employed. Some of the sera did not reach the final high titre until as many as 20 doses had been given, spread over six months. I found that a period of rest in the process of immunisation was useful, since the titre which had before been stationary began to rise satisfactorily again on resumption.

The object of this prolonged immunisation was to procure sera of high titre so that a considerable range of dilution might be employed for comparative tests on different strains, and also so that possible "group agglutinins" might be reduced as much as possible in amount relative to the agglutinins more special for the strain.

Technique of agglutination tests.

The macroscopic method was again used throughout, the mixtures of serum and coccal suspension being incubated for 24 hours at 55° C.

Suspensions were made from glucose-ascitic agar cultures of 24 hours' growth sown from 24 hour egg cultures, the growth being weighed moist and suspended in phenol-saline (0.5 p.c. phenol) at the rate of 2 mg. per c.c.; these were then heated for an hour at 65° C. and kept as stock suspensions. They remained agglutinable for many months, the agglutinability in general tending to increase rather than diminish. In addition, freshly-prepared suspensions (unheated) of the same strength were tested from time to time. These suspensions tended fairly rapidly to become inagglutinable, the rate of change varying very much with different strains.

The mixtures were put up in Durham's tubes calibrated in two equal portions, each containing about 0·3 c.c.; the diluted serum was first put in, then the suspension run in with violence so as to ensure mixture. The use of these small tubes effects a considerable economy in the amount of serum necessary for tests, while providing a sufficient column of suspension for estimating changes resulting from agglutination.

Agglutination of meningococci of cerebro-spinal origin.

In Table I, subjoined, are given the highest titres at which complete agglutination resulted in the case of 60 meningococci of spinal origin with monovalent sera produced by 9 strains isolated from adult cases of the specific disease during the epidemic season, 2 being from the naso-pharynx and 7 from the spinal fluid. As will be seen later, the titre varies with different suspensions of the same strain, but the figures here represent the maximum agglutinability of the various strains with each serum, "maximum" because the most sensitive suspensions were used (old stock heated suspensions) and because the highest value attained in any one experiment was selected.

TABLE I.

Agglutination of spinal strains of meningococci with sera produced by known pathogenic strains.

Serial No.	Strain.	P 1 Serum Titre 1–2,000	A 17 Serum Titre 1–1,800	C.S. 8 Serum Titre 1–2,000	A 13 Serum Titre 1–1,500	A 10 Serum Titre 1–1,500	A 24 Serum Titre 1–1,000	C.S. 14 Serum Titre 1–1,500	C.S. 16 Serum Titre 1–1,500	P 2 Serum Titre 1–2,000
1	C.S. 1	2,000	1,500	1,000	100	100	100	100	100	100
2	C.S. 2	2,000	2,000	1,500	100	100	o	100	100	100
3	C.S. 3	2,000	1,500	1,000	100	500	100	o	100	100
4	C.S. 5	2,000	2,000	1,000	100	500	100	o	100	500
5	C.S. 6	2,000	1,500	1,000	100	1,000	100	o	100	100
6	C.S. 7	2,000	1,000	500	o	500	100	o	100	100
7	C.S. 17 (1)	2,000	2,000	500	500	500	o	o	o	100
8	C.S. 18	2,000	2,000	1,500	100	100	100	o	o	100
9	C.S. 21	1,500	1,500	1,000	100	100	100	o	100	100
10	C.S. 23	2,000	1,000	1,000	100	100	o	o	o	500
11	C.S. 24	2,000	1,000	1,000	100	100	o	o	o	500
12	C.S. 25	2,000	1,500	1,000	500	100	50	o	o	100
13	C.S. 27	2,000	2,000	1,500	500	500	100	o	o	100
14	A 3	2,000	1,500	500	100	500	100	o	100	100
15	A 4	2,000	2,000	1,500	100	100	100	o	100	500
16	A 6	2,000	1,500	1,000	500	500	50	o	o	100
17	A 9	2,000	2,000	1,000	100	500	100	o	100	100
18	A 11	2,000	2,000	1,000	100	500	100	o	100	100
19	A 12	2,000	2,000	1,000	100	100	100	o	100	100
20	A 14	2,000	2,000	1,000	500	500	100	o	100	100
21	A 15	2,000	2,000	1,000	100	100	100	o	100	100
22	B 2	1,500	2,000	1,000	100	100	o	o	o	o
23	A 18	2,000	1,500	1,000	100	500	100	o	100	100
24	A 17	1,500	1,800	1,000	100	100	o	o	o	100
25	C.S. 8	500	500	2,000	100	100	100	o	o	o
26	A 7	500	500	2,000	100	100	100	o	o	o
27	C.S. 20	500	1,000	2,000	100	500	100	100	o	100
28	C.S. 4	500	1,500	1,500	1,500	1,000	100	100	100	100
29	A 13	500	500	1,000	1,500	1,000	100	100	100	100
30	A 23	500	100	o	1,000	1,500	100	100	500	1,000
31	A 1	500	1,500	1,000	500	500	100	100	500	100
32	A 16	100	500	1,000	100	500	100	o	o	o
33	A 2	100	500	500	o	500	500	100	500	100
34	B 12	100	500	500	100	500	o	o	o	o
35	A 10	500	1,000	1,000	500	1,500	50	100	500	100
36	A 24	o	o	100	100	500	1,000	1,000	1,500	2,000
37	A 22	o	o	o	o	100	1,500	1,000	1,500	1,500
38	C.S. 9	o	100	o	o	o	500	1,000	1,500	2,000
39	C.S. 10	o	100	o	o	o	100	1,000	1,500	1,500
40	C.S. 11	o	100	o	o	100	500	1,000	1,500	2,000
41	C.S. 12	o	o	o	o	100	100	1,000	1,200	2,000
42	C.S. 14	o	100	o	o	500	100	1,500	1,500	1,500
43	C.S. 15	o	100	o	o	100	100	1,000	1,500	1,500
44	C.S. 16	o	o	o	100	500	100	1,000	1,500	1,500
45	C.S. 17 (2)	100	o	o	100	o	100	1,000	1,200	1,500
46	C.S. 19	o	o	o	o	o	100	500	500	2,000
47	C.S. 22	o	100	o	o	o	500	1,000	1,500	2,000
48	C.S. 26	o	o	100	o	o		1,000	1,500	2,000
49	A 20	o	o	o	o	o	100	1,000	1,500	1,500
50	B 7	o	o	o	o	100	100	1,500	1,500	1,500
51	B 6	o	o	o	o	100	100	1,000	1,200	1,500
52	B 9	o	o	o	o	o	o	1,000	1,000	1,500
53	B 11	o	100	o	o	o	50	500	1,000	1,500
54	B 4	o	o	o	o	100	100	1,000	800	1,000
55	A 25	o	100	o	o	100	100	1,000	500	1,500
56	B 8	o	100	o	o	100	50	500	100	500
57	B 1	o	o	o	o	100	o	500	100	500
58	B 3	o	100	o	o	100	o	100	100	500
59	B 5	o	o	o	o	100	o	100	o	100
60	B 10	o	100	o	o	100	100	o	100	o

This table demonstrates the relationships to each other of strains of spinal origin as shown by agglutination. In my former report I showed that agglutination tests with two monovalent sera, "Boscombe" and "Clayton," divided the spinal strains sharply into two groups, the first group agglutinating completely at 1-100 to 1-800 with "Boscombe" serum and either not at all or very slightly at 1-100 with "Clayton" serum, while with the second group the behaviour was reversed. With the stronger sera here employed this grouping is still more evident. Taking the first and last columns, headed sera P 1 and P 2 ("Boscombe" and "Clayton"), it will be seen that the first 24 strains agglutinate to the full titre or nearly with the former and, with two exceptions of 1-500, agglutinate only up to 1-100 or less with the latter; on the other hand 20 other strains, 36 to 55, agglutinate up to the full titre or nearly with serum P 2 and slightly or not at all with serum P 1. Thus in the case of 44 strains a sharp division into groups exists on the strength of agglutination.

This leaves 16 in which agglutination by these group sera left the classification in doubt. 11 of these, numbers 25-35, show agglutination with the main Group I serum varying from 100 to 500 and with the main Group II serum from 0 to 100, with one exception which agglutinates to 1,000 with the latter serum.

The last mentioned strain might be classed as Group II, but in the case of all the others the agglutination results leave one either entirely in doubt or with a slight leaning to place them in Group I. Finally five strains, numbers 56-60, do not agglutinate at all with Group I serum and with Group II serum agglutinate at most up to 1-500. The tendency would be to place these in Group II, but again the position must remain in doubt since agglutination to 1-500 with such strong sera cannot be regarded as of decisive significance.

On looking now at the columns under A 17 serum and C.S. 16 serum exactly the same results are obtained except that with A 17 there are greater variations in the high titres obtained with the strains already placed in the main Group I, e.g., 3 strains reach only 1-1,000, while 9 reach 1-1,500, and 12 attain the full titre of 1-2,000; further, some of the strains which leaned towards Group I now show more definite alliance, reaching dilutions of 1-1,000 in two cases and 1-1,500 in other two; the strains 56-60 which inclined to Group II are now almost entirely indifferent, reaching titres of 1-100 at most, a titre which is also attained by the Group I strains with the Group II serum.

Sera A 17 and C.S. 16 thus do not alter the subdivision already noted, and the strains producing them must be regarded as examples of Group I and Group II respectively.

Serum C.S. 14 is closely comparable with C.S. 16 in its effects and picks out again the Group II strains, agglutinating them to approximately full titre.

The results of agglutination with the other sera, C.S. 8, A 13, A 10 and A 24, may be summed up as follows: the first three, prepared with strains already placed as inclining towards

Group I, agglutinate Group I strains better than Group II and pick out in each case a small number of the former strains by agglutinating them to the full titre of the serum, while serum A 24, prepared with a strain apparently typical of Group II, agglutinates both groups indifferently, but neither well; it picks out, however, one other Group II strain besides itself as reacting to the full titre. These two strains evidently form a sub-group of Group II although their agglutination reactions with the other Group II sera give no evidence of their highly individual character as shown by their behaviour towards serum A 24.

The agglutination tests leave unidentified eight strains which react feebly with all the sera, but one of these, strain A 2 (number 33) has been used to produce a serum, the action of which will be described in a later part of this report. In general it agglutinates Group I strains better than Group II, thus confirming its position as near Group I, but it agglutinates none of the spinal strains, except itself, to high titre, and may therefore represent an aberrant strain or may belong to a natural group of which chance has determined that no other representative should fall into my hands.

If one makes a general survey of Table I it may be noted that, if it be read from the top left-hand corner to the bottom right-hand corner, lines drawn from the top of column C.S. 8 to line 36 in column P 2 and from line 25 in column P 1 to the foot of column C.S. 14 include practically all the high agglutination titres between them.

The explanation of this is the fact that the middle of the horizontal line on which the sera are placed is occupied by sera surmised to represent strains intermediate between Group I and Group II, whilst the sera typical of these two groups occupy respectively the left- and right-hand ends; the middle of the vertical line on which are distributed the various strains is occupied by strains similarly surmised to be intermediate. The striking arrangement of the high titres which results in Table I testifies to the correctness of the surmise, and indicates that the agglutinogenic action of these intermediate strains is in agreement with their reactions to the main group sera.

In the case of eight strains out of the 60, classification with the sera employed has failed owing to their poor response to all. Three of these strains appear to incline more to Group I than to Group II, while with the remaining five the inclination is reversed. Each of these sets may represent a true sub-group, or they may consist of highly specialised individuals.

This question could only be answered by preparing sera with each, and testing the agglutinating properties of these sera against a representative selection of strains, i.e., by determining their general and special agglutinogenic action.

Variations in agglutinability of the meningococcus in culture.

Special attention to this point was evidently necessary, since neglect in taking account of it might lead to serious error not only in the more purely scientific question of making a classification but in the very practical one of estimating the value of

particular anti-meningococcus sera as remedial agents in infections with particular strains of the meningococcus.

As has been stated, heated suspensions of the various strains remain very stable in their agglutinability, the only change, if any, being a gradual one towards increase of sensitiveness, not only towards the sera agglutinating originally to a high titre but also to those agglutinating originally only to a slight extent. In other words, heating the suspension fixes permanently the agglutinating properties which the cocci happen to possess in the fresh unheated state either as a result of the strain's true position among meningococci or as the result of a temporary variation. But such temporary variations between different cultures of the same strain occur to such an extent that suspensions made at different times from subcultures on Kutscher's medium or ascitic agar of strains preserved on egg at 37° C. show very wide divergence.

A good deal of time was spent on trying to correlate these divergences with the differences seen in colonies of the same strain on the same plate. These differences are particularly striking when material taken from an old egg culture (three weeks old or more) is plated out on serum or ascites media. On such plates colonies of two types appear in varying proportion; one type is translucent or very finely granular, resembling in appearance and structure the typical colony as isolated directly from the naso-pharynx or the spinal fluid; the other is opaque, coarsely granular and easily distinguishable. Some colonies are apparently of mixed type and show sharply defined sectors of translucent growth in the opaque disc. After one or two subcultures on serum media these coarsely granular colonies yield only the translucent type of growth, but cultures on egg from single colonies, whether translucent or granular, show after three weeks or so the same mixture on replating.

On investigating the serological reactions of these different types of growth it was found that in some cases the opaque type consisted of relatively inagglutinable cocci, while the translucent type gave the reactions regarded as normal for the strain; but in other cases the behaviour was reversed, and the conclusion I came to was that no correlation between type of growth and agglutinability existed. The same holds true for differences in the size of colonies on the same plate.

The cause for the appearance of the two types of colony may be that in an old egg culture certain cocci have become so altered in the conditions of their growth by existence on an exhausted medium that when given an opportunity of forming colonies on fresh material they are unable at first to grow in the manner typical of meningococci from young and vigorous cultures.

In any case, their rapid reversion to type in this matter indicates that no profound mutation has occurred.

But these observations are of significance in showing that the varying agglutinability of different suspensions of the same strain may be easily explained by the predominance in them either of highly agglutinable or of feebly agglutinable cocci, according as

the culture used for the suspension starts from cocci producing readily agglutinable colonies or from those producing the reverse.

In Table II examples are given of the different titres shown by the same strain with different fresh suspensions; all these suspensions were of the standard strength, 2 mg. per c.c. In the case of columns (3) and (4) they were made by subculturing on ascitic-agar single colonies of the different appearances described; column (3) shows the results obtained with the translucent variety and column (4) those with the opaque. Columns (1) and (2) represent growth from colonies of typical appearance from young cultures. The Arabic numerals indicate the dilution of serum at which complete agglutination occurred, while the symbols +, + +, and + + + indicate degrees of agglutination short of complete at 1-100.

TABLE II.

Variations in agglutination with fresh suspensions.

Strain.	Serum P. 1				Serum P. 2.			
	1	2	3	4	1	2	3	4
C.S. 1 ...	1,500	500	1,500	—	+ +	+ + +	100	—
C.S. 2 ...	1,500	1,000	1,500	1,500	+ + +	100	100	100
C.S. 3 ...	1,500	1,500	1,500	—	100	100	100	—
C.S. 5 ...	1,000	1,500	1,500	—	+ +	100	500	—
C.S. 6 ...	1,000	500	500	1,500	o	+ + +	+ +	100
C.S. 7 ...	1,500	500	500	1,000	+ + +	+ + +	+ + +	100
C.S. 17(1) ...	1,500	1,000	500	1,500	100	+ + +	+ +	100
C.S. 18 ...	500	1,000	1,500	—	+	+ + +	100	—
C.S. 23 ...	1,500	500	1,500	1,500	+	+ +	100	100
C.S. 24 ...	500	1,500	1,500	—	+ +	+ + +	100	—
A. 3	1,500	100	1,500	1,500	+ + +	+ + +	+ +	+ + +
A. 4	1,500	1,000	500	—	500	+ +	+ +	—
A. 6	500	500	100	500	+ + +	+ + +	+ + +	+ + +
A. 9	1,500	1,500	1,500	—	+ + +	+ + +	+ +	—
A. 11	1,500	100	1,500	—	+ + +	+ + +	+ +	—
A. 12	1,500	500	—	—	100	+	—	—
A. 14	1,000	1,500	—	—	+ + +	100	—	—
A. 15	1,000	1,500	1,000	—	+ +	100	+ +	—
A. 18	1,500	1,500	1,500	—	100	+ + +	+ +	—
A. 17	+ + +	500	—	—	+	+ + +	—	—
C. S.8 ...	100	100	o	100	+	+	+ +	o
A. 7	1,000	100	—	—	+ + +	+	—	—
C.S. 20 ...	500	100	500	—	+ +	+ +	+ + +	—
C.S. 4 ...	o	100	100	100	100	o	+ + +	100
A. 13	100	100	100	100	100	+ +	+ + +	100
A. 23	o	o	—	—	500	+ +	—	—
A. 1	1,000	100	o	—	100	100	o	—
A. 16	100	100	+	—	+	+ +	+ +	—
A. 2	+ +	100	+ + + +	+ +	100	100	100	100
A. 10	100	100	—	—	100	100	—	—
A. 24	o	o	o	o	1,500	100	100	500
A. 22	o	o	—	—	1,500	1,000	—	—
C.S. 9 ...	o	o	o	+	1,000	100	1,500	1,500
C.S. 10 ...	o	o	o	—	1,000	100	1,000	—
C.S. 11 ...	o	o	o	—	1,000	500	1,500	—
C.S. 12 ...	o	o	o	+	1,500	100	1,500	500
C.S. 14 ...	o	o	o	o	1,000	100	1,000	1,000
C.S. 16 ...	o	o	o	—	1,000	1,000	1,000	—
C.S. 19 ...	o	o	o	—	1,000	1,500	1,500	—
C.S. 22 ...	o	o	o	o	1,500	1,000	100	1,500
A. 20	o	o	o	o	1,500	1,000	500	500
A. 25	o	+ +	o	o	1,000	100	1,000	1,500

It will be observed that at different times with both groups of strains the titre may vary from 1-100 to 1-1,500, e.g., with strains A 3 and C.S. 12, and that although in general the variation does not reverse the placing of the various strains in the two main groups, yet in many instances, e.g., A 3, A 4, A 6, A 17, C.S. 4, etc., the difference in titre shown, when minimum and maximum agglutinations with the respective group sera are compared, is not such as to give a definite answer as to serological grouping. Hence chance may readily determine that a given strain, though definitely of the main Group I as seen by more extensive tests, may appear as the result of a single test either quite doubtful or even tending towards the wrong group.

The variation just illustrated may, and probably does, depend on differences in the different suspensions of an extrinsic character, i.e., in the physical condition of the cocci composing them, and not on intrinsic differences of chemical composition such as differentiate the groups. But one strain in my possession, strain C.S. 17, has shown differences of the latter type. Originally on isolation it agglutinated to the full titre with the main Group I serum, and only faintly with that of Group II; when a fresh emulsion was tested a month later, the behaviour was exactly reversed; two months later it again became a typical Group I strain, giving only traces of agglutination with Group II serum. As a result, I have now in my possession two strains isolated from the same colony on a plate inoculated with cerebro-spinal fluid; one strain C.S. 17 (1) behaves in all respects like the 24 strains making up the main Group I, while the other, C.S. 17 (2), is almost equally characteristic of Group II.

The significance of this apparently profound change will be discussed later with special reference to the possibility of original mixture of the two strains.

It may safely be assumed, I think, that if differences of the degrees described occur in strains during culture on artificial media, they are still more likely to occur under the changing conditions of the susceptible or resistant human body.

Further examples of these serological changes will be given when absorption tests have been discussed, since, in estimating the degree of importance to be attached to alteration in serological reactions, agglutination results are not sufficiently decisive; the absorption of agglutinin from a particular serum, it is generally held, is the most satisfactory criterion for establishing identity of an unknown strain with the strain producing the serum.

Classification by agglutination.

I have tried to show in Table I that by agglutination reactions alone it is possible to divide this collection of 60 spinal strains into two main groups supplemented by at least five sub-groups more or less nearly allied to Group I, one sub-group actually within Group II and one probably related to it; the term sub-group in each case indicates merely that the strains representing it are numerically less important than those of the main groups.

It does not indicate that the sub-groups lie within the main Groups I and II; they may possess equally pronounced individuality, and all that can be said is that sub-groups 1 to 5 are more nearly allied to Group I while sub-group 7 inclines to Group II. In Table III the reasons are set out for separating each of these sub-groups, as also the numbers of the strains which go to make them up.

TABLE III.

Analysis of Table I showing expanded classification of spinal strains in relation to the two main groups.

No. of Group or Sub-group.	Strains composing these:	Relationships to the main groups.		Characteristics peculiar to each set of strains classed as identical.
		Group I.	Group II.	
Main Group I	Nos. 1–24	These strains constitute this group	Slight and indecisive agglutination with Group II sera.	Agglutination to approximately full titre with Group I sera.
Sub-Group (1)	25, 26, 27 (C.S. 8, A 7, C.S. 20).	Agglutinated to 1–500 with main Group I sera.	Agglutinated to 1–100 only with Group II sera.	Agglutination to full titre with serum C.S. 8, prepared with strain No. 25.
Sub-Group (2)	28, 29 (A 13, C.S. 4).	Agglutinated to 1–500 with main Group I sera.	Agglutinated to 1–100 only with Group II sera.	Agglutination to full titre with serum A 13, prepared with strain No. 29.
Sub-Group (3)	30, 35 (A 23, A 10)	Agglutinated to 1–500 with main Group I sera.	Agglutinated to 1–500 with Group II sera.	Agglutination to full titre with serum A 10, prepared with strain No. 35.
Sub-Group (4)	33 (A 2).	Agglutinated to 1–500 with main Group I serum.	Agglutinated to 1–500 with Group II sera.	Agglutination to full titre with serum A 2, prepared with No. 33: no other spinal strain so agglutinated.
Sub-Group (5)	31, 32, 34 (A 1, A 16, B 12).	Agglutinated to 1–500 or higher but not to full titre with main Group I serum.	Agglutinated below 1–500 with Group II sera.	Fail to agglutinate to full titre with any spinal sera: ? identical with each other: ? separate individual groups.
Main Group II	36 to 55	Agglutinated to slight and indecisive extent by main Group I sera.	These strains constitute this group	Agglutination to approximately full titre with Group II. sera.
Sub-group (6) within Main Group II.	36, 37 (A 24, A 22).	As above ...	Apparently indistinguishable.	Agglutination to full titre with serum A 24 prepared with Strain No. 36.
Sub-Group (7)	56–60 (B 8, B 1, B 3, B 6, B 10).	As above ...	Agglutinated to 1–500 or less with Group II sera.	Fail to agglutinate to full titre with any spinal sera; agglutinate better with Group II than with Group I: ? identical with each other: ? separate individual groups.

But in practice such classification by agglutination alone is out of the question. It would involve repeated testing of each strain to be classified; the tests would have to be performed with

several sera, each known to be different, and strains of established classification would have to be tested at the same time for comparison and as controls.

A single test with selected sera would be insufficient because the agglutination titre of a particular strain for a particular serum may vary within wide limits with suspensions prepared at different times: one suspension may reach even less than half the titre attained by another, and a single indecisive result with a particular serum cannot be regarded as excluding membership of the corresponding group. Furthermore, with certain sub-group sera, *e.g.*, serum C.S. 8, the agglutination reactions of some strains foreign to the sub-group differ on the average only slightly from those actually belonging to it, the differences being well within the limit of possible variations.

It will be seen, however, in the following section that by the test for absorption of agglutinin the classification suggested by the agglutination reactions of Table I and defined in Table III receives a considerable amount of support, the differences brought out by absorption being much sharper and less subject to variation.

Absorption Tests.

Technique.—My general plan of procedure has been to suspend a weighed quantity of the bacterial growth (from cultures on ascitic-agar of 24 hours at 37° C.) in a given amount of serum diluted 1-50. The quantity chosen was that which, with the strain homologous to the particular serum, was necessary to reduce the agglutinating power for itself to nearly *nil*—*i.e.*, till the serum, which before absorption agglutinated its homologue, say, to 1-1,500, failed to give complete agglutination at 1-100 (though preferably giving distinct traces of agglutination at this dilution). This quantity varied with different sera from 5 mg. to 20 mg. of culture per c.c. of serum diluted 1-50. The mixture was kept in the ice-chest overnight or longer as convenient, a control specimen of the same serum dilution being similarly treated. The cocci were removed by prolonged centrifuging, and the clear fluid was then tested for persisting agglutinin on a suspension of the strain producing the serum; usually other strains more or less closely allied to this were used as test suspensions at the same time.

In a few cases stored suspensions of cocci were employed for absorption instead of the fresh growth, but they were rather unsatisfactory owing to the difficulty of removing them with the centrifuge in cases where agglutination in the mixture was incomplete. The fresh suspensions, on the other hand, even when not agglutinated, were readily removed by the high-speed centrifuge, giving clear supernatant fluid with which to test agglutination.

Agglutination was tested with this fluid undiluted and with increasing dilutions of it up to the maximum known to give complete agglutination in the case of the control specimen, so that degrees of absorption were detectable from "complete," where only traces of agglutinin remained, to "nil," where the

serum before and after absorption gave in each case complete agglutination at the highest dilution.

Groups and Sub-Groups.

The main Group I.

In Table IV, subjoined, are given the degrees of absorption from the main Group I serum, P 1, with various spinal strains representing this main group (*vide* Table I), and also with strains more or less closely allied to this group (*vide* Table III); as controls two strains were taken, which on agglutination belonged to Group II. The quantity of culture employed for absorption was in each case 8 mg. suspended in 1 c.c. of P 1 serum diluted 1-50. The suspensions used for testing the persistence or removal of agglutinin were old stock suspensions of high agglutinability.

The symbol C, when used to indicate agglutination, means that complete deposit of the suspended cocci was found, the supernatant fluid being free from turbidity; the symbols + + +, + +, and + indicate diminishing amounts of deposit, the supernatant fluid remaining more or less turbid.

In the columns headed absorption the symbol C indicates that absorption was regarded as *complete*, complete absorption being taken to have occurred when even the 1-100 dilution failed to agglutinate the test suspension completely; absorption designated as + + + means that, though agglutination was still complete at 1-100, it was definitely incomplete at 1-600; while + indicates that agglutination, though complete at 1-600, was incomplete at 1-1,000.

TABLE IV.

Absorption of agglutinin from serum P 1.

Serum.	Agglutination with Homologous Strain P 1.					Agglutination with Related Strain C.S. 3.					Absorption of Agglutinin for Homologous Strain P. 1.	Absorption of Agglutinin for Strain C.S. 3.
Control unabsorbed.	100 c	600 c	1000 c	1400 c	2000 + + +	100 c	600 c	1000 c	1400 c	2000 + + +		
Absorbed by Strain.												
P 1 ...	+	o	o	o	o	+	o	o	o	o	c	c
C.S. 1 ...	+	o	o	o	o	+	o	o	o	o	c	c
C.S. 2 ...	+	o	o	o	o	+	o	o	o	o	c	c
C.S. 3 ...	+ + +	trace	o	o	o	+	o	o	o	o	c	c
C.S. 5 ...	c	+ +	o	o	o	+ +	o	o	o	o	+ + +	c
C.S. 6 ...	c	+ +	o	o	o	+ +	o	o	o	o	+ + +	c
C.S. 7 ...	+ +	o	o	o	o	+	o	o	o	o	c	c
C.S. 17(1)	c	+ +	o	o	o	+	o	o	o	o	+ + +	c
C.S. 18 ...	+ +	o	o	o	o	+ +	o	o	o	o	c	c
C.S. 21 ...	c	+ +	o	o	o	+ +	o	o	o	o	+ + +	c
C.S. 24 ...	+	o	o	o	o	o	o	o	o	o	c	c
C.S. 25 ...	+	o	o	o	o	o	o	o	o	o	c	c
C.S. 27 ...	+	o	o	o	o	o	o	o	o	o	c	c
A 3 ...	c	o	o	o	o	o	o	o	o	o	+ + +	c
A 4 ...	+ +	o	o	o	o	o	o	o	o	o	c	c
A 6 ...	c	o	o	o	o	+ +	o	o	o	o	+ + +	c
A 9 ...	+ + +	o	o	o	o	+	o	o	o	o	c	c
A 11 ...	+	o	o	o	o	o	o	o	o	o	c	c
A 12 ...	+	o	o	o	o	o	o	o	o	o	c	c
A 14 ...	c	o	o	o	o	+ +	o	o	o	o	+ + +	c
A 15 ...	c	+ +	o	o	o	c	+	o	o	o	+ + +	+ + +
A 18 ...	c	o	o	o	o	o	o	o	o	o	+ + +	c
A 17 ...	c	+	o	o	o	c	+ +	o	o	o	+ + +	+ + +
B 2 ...	c	o	o	o	o	+ +	o	o	o	o	+ + +	c
C.S. 8 ...	c	c	+ + +	+ +	+	c	c	c	c	+ +	+	trace ?
A 7 ...	c	c	c	c	+ +	c	c	c	c	+ +	trace ?	trace ?
C.S. 20 ...	c	c	c	c	+ +	c	c	c	c	+ +	trace ?	trace ?
C.S. 4 ...	c	c	+ + +	+ +	+	c	c	c	c	+ +	+	trace ?
A 13 ...	c	c	+ + +	+ +	+	c	c	c	c	+	+	trace ?
A 1 ...	c	c	+ + +	+	o	c	c	c	c	+	+	trace ?
A 2 ...	c	c	c	+ +	o	c	c	c	c	+	trace	trace ?
A 16 ...	c	c	+ +	+	o	c	c	c	+ + +	+ +	+	trace.
B 12 ...	c	c	c	c	+	c	c	c	c	+	trace ?	trace ?
B 3 ...	c	c	c	c	+	c	c	c	c	+	trace ?	trace ?
A 10 ...	c	c	c	c	+ + +	c	c	c	c	+ +	o	trace ?
C.S. 14 ...	c	c	c	c	+ + +	c	c	c	c	+ +	o	trace ?
*N 19 ...	+ +	o	o	o	o	+	o	o	o	o	c	c

It will be seen that the first 24 strains, P 1 to B 2, which (*vide* Tables I and III) were put in the main Group I in virtue of their high agglutination with serum P 1, give complete, or almost complete, absorption of the agglutinin acting on strain P 1, while those strains which showed relationship but not identity with Group I—and also the control Group II strains—remove either small amounts or none. Similarly, the agglutinin present in P 1 serum for another member of the main Group I is in general removed completely by the main Group I strains and barely affected by the others.

This result, which has been many times repeated, is very clear and definite; the minor variations in absorptive capacity, indicated in this table among the different strains within the main

* To avoid repetition of the table the absorptive capacity of N 19 is inserted here and will be discussed on p. 147 in its place as a nasopharyngeal strain.

group, have not been reproduced with regularity in duplicate experiments, and probably indicate only slight temporary alterations in individual culture masses of the various strains. This main Group I is thus well-defined and relatively homogeneous; and I may note incidentally that similar behaviour in the case of certain coli-form bacilli of the "food-poisoning" group has been used by some authorities as the criterion for establishing biological species.

In the following table (Table V) are indicated the results of absorption from another main Group I serum, the serum produced by strain A 17, which, though irregular in its agglutination with serum P 1 (*vide* Table II), yet at times reaches the full titre, and, as has just been seen, gives almost complete absorption of agglutinin from it.

The quantities used were 10 mg. of culture per c.c. of 1-50 dilution of the serum and the test emulsions were the homologous strain A 17 and another main Group I strain, C.S. 2, of typical behaviour.

TABLE V.

Absorption of agglutinin from serum A 17.

Serum.	Agglutination with Homologous Strain A. 17.				Agglutination with Related Strain C.S. 2.				Absorption of Agglutinin for Homologous Strain A. 17.	Absorption of Agglutinin for Strain C.S. 2.
Control Unabsorbed.	100 c	500 c	1,000 c	1,500 c	100 c	500 c	1,000 c	1,500 c		
Absorbed by Strain.										
C.S. 1 ...	c	trace	o	o	+ + +	o	o	o	+ + +	c
C.S. 3 ...	c	trace	o	o	+ + +	o	o	o	+ + +	c
C.S. 5 ...	+ + +	o	o	o	+ + +	o	o	o	c	c
C.S. 7 ...	c	+	o	o	+ + +	o	o	o	+ + +	c
C.S. 17(1)	c	trace	o	o	+ + +	o	o	o	+ + +	c
C.S. 21 ...	+ + +	o	o	o	+	o	o	o	c	c
C.S. 27 ...	c	o	o	o	+ + +	o	o	o	+ + +	c
A. 3 ...	+ + +	o	o	o	+ + +	o	o	o	c	c
A. 6 ...	c	+ +	o	o	c	o	o	o	+ + +	+ + +
A. 9 ...	c	+ +	o	o	c	o	o	o	+ + +	+ + +
A. 15 ...	c	+	o	o	c	o	o	o	+ + +	+ + +
A. 17 ...	+ + +	+	o	o	c	o	o	o	c	+ + +
B. 2 ...	c	o	o	o	+ + +	o	o	o	+ + +	c
A. 7 ...	c	c	c	c	c	c	c	+ + +	o	trace
C.S. 4 ...	c	c	c	c	c	c	c	c	o	o
A. 1 ...	c	c	c	c	c	c	c	+	o	trace
B. 12 ...	c	c	c	c	c	c	c	+ + +	o	trace
*N. 19 ...	+ + +	o	o	o	+	o	o	o	c	c

The results are very similar to those shown in Table IV. Differences in absorptive capacity between C and + + + coincide in some cases with similar differences in the former table, while in other cases absorptions indicated as + + + in Table IV here reach completeness. Such variations and coincidences may represent a tendency to subgrouping within this main group, but, as has been noted above, they are not sufficiently regular to justify any such conclusion.

The object of inserting Table V is to show again the homo-

* Naso-pharyngeal strain, see p. 147.

geneous nature of the main Group I, seen in Table IV; for this purpose the serum produced by A 17 was selected, as A 17 is one of the main group strains which showed the greatest tendency to diverge; further, A 17 is a strain of spinal origin, whereas P 1, used to produce the serum P 1, which has been chosen as the main Group I serum, was isolated from the naso-pharynx; yet the results with A 17 serum are practically indistinguishable.

Sub-Group (1).

In the next table (Table VI) absorption tests are given, using the same strains as in Table IV, but absorbing from the serum C.S. 8, produced by one of the strains which, on agglutination results, show relationship but certainly not identity with the main Group I. The technical details are exactly the same, and the masses of culture employed for absorption came from the same ascitic-agar slopes as in the experiment summarised in Table IV; the symbols employed are also the same.

TABLE VI.

Absorption of agglutinin from serum C.S. 8.

Serum.	Agglutination with Homologous Strain C.S. 8.					Agglutination with Related Strain A. 7.					Absorption of Agglutinin for Homologous Strain C.S. 8.	Absorption of Agglutinin for Strain A. 7.
Control unabsorbed.	100 c	600 c	1000 c	1400 c	2000 ++	100 c	600 c	1000 c	1400 c	2000 +++		
Absorbed by Strain.												
P. 1 ...	c	c	+++	+	o	c	c	c	++	o	+	trace
C.S. 1 ...	c	c	c	++	o	c	c	c	+++	o	trace	trace
C.S. 2 ...	c	c	c	+++	+	c	c	c	+++	+	trace	trace
C.S. 3 ...	c	c	+++	++	o	c	c	c	+++	+	+	trace
C.S. 5 ...	c	c	+++	++	o	c	c	c	c	++	+	o
C.S. 6 ...	c	c	c	+++	+	c	c	c	c	++	trace	o
C.S. 7 ...	c	c	c	+++	+	c	c	c	c	++	trace	o
C.S. 17(1)	c	c	c	+++	+	c	c	c	c	++	trace	o
C.S. 18 ...	c	c	c	+++	+	c	c	c	+++	++	trace	trace
C.S. 21 ...	c	c	+++	+	o	c	c	c	+++	+	+	trace
C.S. 24 ...	c	c	c	+++	+	c	c	c	c	+	trace	o
C.S. 25 ...	c	c	c	+++	+	c	c	c	c	+	trace	o
A. 3 ...	c	c	c	+++	+	c	c	c	c	++	trace	o
A. 4 ...	c	c	c	c	+	c	c	c	c	+	o	o
A. 6 ...	c	c	c	c	++	c	c	c	+++	+	o	trace
A. 9 ...	c	c	c	+	o	c	c	+++	++	o	trace	+
A. 11 ...	c	c	c	c	+	c	c	c	c	o	o	o
A. 12 ...	c	c	c	c	+	c	c	c	c	++	o	o
A. 14 ...	c	c	c	c	+	c	c	c	+++	+	o	trace
A. 15 ...	c	c	c	c	++	c	c	c	c	+	o	o
A. 18 ...	c	c	c	+++	+	c	c	c	+++	+	trace	trace
A. 17 ...	c	c	c	c	++	c	c	c	c	++	o	o
B. 2 ...	c	c	+++	+	o	c	c	c	+	+	+	trace
C.S. 8 ...	++	o	o	o	o	o	o	o	o	o	c	c
A. 7 ...	+++	o	o	o	o	++	o	o	o	o	c	c
C.S. 20 ...	+	o	o	o	o	o	o	o	o	o	c	c
C.S. 4 ...	c	c	c	+++	+	c	c	c	c	++	trace	o
A. 13 ...	c	c	c	++	+	c	c	c	c	++	trace	o
A. 1 ...	c	c	c	+++	++	c	c	c	c	+	trace	o
A. 2 ...	c	c	++	+	o	c	c	+++	+	o	+	+
A. 16 ...	c	c	c	c	++	c	c	c	c	++	o	o
B. 12 ...	c	c	c	+	+	c	c	c	+	o	trace	trace
B. 3 ...	c	c	c	c	++	c	c	c	c	++	o	o
A. 10 ...	c	c	c	++	+	c	c	c	c	+	trace	o
C.S. 14 ...	c	c	c	c	++	c	c	c	c	++	o	o

The results are equally sharp and definite. Absorption is complete with the three strains (including the homologue) which in Table I were seen to reach the full titre with this serum, namely, strains C.S. 8, A 7 and C.S. 20. On the other hand, the numerous strains of the main Group I, which agglutinated fairly strongly with serum C.S. 8, fail entirely, or almost entirely, to remove the agglutinin for either strain C.S. 8 or A 7, as also do the other strains which were shown to be related, but not identical with the main Group I.

Here, therefore, there is a group, which may be called the C.S. 8 group (sub-group (1) in Table III), quite as well defined apparently as the main Group I, the three strains composing it having on the results of absorption as much right to specific differentiation as the much larger group, although the agglutinogenic action of the type strain C.S. 8, unlike the type strain of the main group, P 1, is less "pure," since its serum agglutinates many of the latter group to almost the full titre. The same overflow of the agglutinating action to strains not belonging to the group was observed in connection with serum A 17, which, as has just been seen, seems as pure a type of the main Group I as does C.S. 8 for the C.S. 8 group, when absorption is resorted to instead of agglutination as the test.

So striking was this selective action in the absorption test with serum C.S. 8 that further experiments were done in which very large amounts of culture were employed, 80 mg. in one c.c. of 1-100 dilution of serum, to see whether protein-complexes capable of absorbing agglutinin were present at all in these related but not identical strains. No increase in absorption appeared, although very marked agglutination with abundant deposit had occurred in the absorbing mixture; the serum still agglutinated completely up to 1-1,500 after absorption with all the main Group I strains except two, (A 9 and A 12), with which slight absorption had taken place, agglutination being complete only up to 1,000. The agglutinin for the strains themselves contained in serum C.S. 8, in most cases sufficient to give complete agglutination at 1-1,000, had, however, completely disappeared after absorption.

What explanation can be given for this cross-agglutination without cross-absorption in the case of these two strains and sera C.S. 8 and P. 1? The following hypothesis would appear to meet the case. The two special antigens are present in both the strains C.S. 8 and P. 1; in the former strain the amount of special P. 1 antigen is small and in the latter the amount of special C.S.8 antigen is small. In the sera produced by the two strains both agglutinins are present, the P. 1 agglutinin being, however, less in amount in C.S. 8 serum and the C.S. 8 agglutinin less in amount in P. 1 serum, so that when each serum is diluted to the full titre the agglutinating action of the "foreign" agglutinin in each case disappears. In consequence when C.S. 8 serum is absorbed by the strain P. 1 only the P. 1 portion of its total agglutinin is removed; but this portion is in any case non-effective at the full dilution so that no diminution in the activity of the C.S. 8 agglutinin is visible after absorption by P. 1. Exactly the same happens when P. 1 serum is absorbed by strain C.S. 8.

There remain eight strains related to Group I on the strength of agglutination tests, but excluded by negative absorption tests from both the groups just discussed.

Sub-Group (2).

Serum A 13, produced by one of these, agglutinates one other strain to the full titre and one to 1-1,000, while most of the main Group I and the sub-group (1) strains are agglutinated up to 1-100 only. Absorption tests with this serum are summarised in Table VII and amply confirm the suspected existence of still another group. The technical details and symbols employed are in general the same as in Tables IV., V., and VI.

TABLE VII.

Absorption of Agglutinin from serum A 13.

Serum.	Agglutination with Homologous Strain A 13.				Agglutination with Related Strain C.S. 4.				Absorption of Agglutinin for Homologous Strain A. 13.	Absorption of Agglutinin for Strain C.S. 4.
Control Unabsorbed.	100 c	300 c	800 c	1200 c	100 c	300 c	800 c	1200 c		
Absorbed by Strain.										
C.S. 1 ...	c	c	c	+	c	c	c	+ + +	trace	o
C.S. 17(1)	c	c	+ + +	+	c	c	c	+	+	trace
C.S. 8 ...	c	c	c	c	c	c	c	c	o	o
C.S. 20 ...	c	c	c	+ +	c	c	+ + +	+ +	o	trace
C.S. 4 ...	+	o	o	o	o	o	o	o	c	c
A 13 ...	+	o	o	o	+	o	o	o	c	c
A 23 ...	c	+ + +	+ +	+	c	c	+ + +	+	+ +	+
A 1 ...	c	c	+ + +	+	c	c	+ +	+	+	+
A 2 ...	c	c	c	+	c	c	c	+	trace	trace
A 16 ...	c	c	+	o	c	c	o	o	+	+
A 10 ...	c	+	o	o	+ + +	o	o	o	+ + +	c
C.S. 16 ...	c	c	c	c	c	c	c	c	o	o
*N 29 ...	+	o	o	o	o	o	o	o	c	c

It will be seen that, of the twelve spinal strains tested, two only, the homologous strain A 13 and strain C.S. 4, give complete absorption, each absorbing the agglutinin for both itself and the other. In addition, strain A 10 gives well-marked absorption of the agglutinin for A 13 and complete absorption of that for C.S. 4, while strain A 23 absorbs the greater part of the agglutinin for A 13. All the others, including strains identified as belonging to the main Group I, the sub-group (1), the main Group II., and others unidentified but related by agglutination to Group I, give more or less definite but slight absorption only.

The results of absorption from serum A 13 are thus less sharply defined than those of the sera just discussed, in the sense that allied but not identical strains exist which also absorb agglutinin, but it is evident that the strains A 13 and C.S.4 have been identified with one another and sharply distinguished from the groups hitherto established; while two other strains, A 10 and A 23, not hitherto identified with any group, have been placed in close relationship with this sub-group (2), of which A 13 is the type.

Sub-Group (3).

In Table VIII., which follows, the results are given of absorption from the serum prepared by inoculation of this A 10. The technique and symbols employed are as in previous absorption experiments.

* Naso-pharyngeal strain, see p. 147.

Table VIII.

Absorption of agglutinin from serum A 10.

Serum.	Agglutination with Homologous Strain A 10.						Agglutination with Related Strain A 13.						Absorption of Agglutinin for Homologous Strain A 10.	Absorption of Agglutinin for Strain A 13.
Control Unabsorbed	100 c	300 c	600 c	800 c	1000 c	1500 +++	100 c	300 c	600 c	800 c	1000 c	1500 +++		
Absorbed by Strain														
C.S. 1	c	c	c	c	++	+	c	c	c	c	+	o	+	+
C.S. 4	c	++	o	o	o	o	++	o	o	o	o	o	+++	c
A 13	+	o	o	o	o	o	o	o	o	o	o	o	c	c
A 23	++	o	o	o	o	o	c	++	o	o	o	o	c	+++
A 1	c	c	c	c	+++	++	c	+++	++	+	o	o	+	+++
A 2	c	c	c	c	+++	++	c	c	c	+++	++	++	+	++
A 16	c	c	c	+	o	o	c	c	+++	+	+	o	++	+++
A 10	o	o	o	o	o	o	+	o	o	o	o	o	c	c
C.S. 16	++	o	o	o	o	o	+++	+++	o	o	o	o	c	c ?
C.S. 14	c	c	c	c	+++	o	c	++	+	o	o	o	+	+++
A 24	c	c	c	+++	+++	+	c	c	c	+++	+++	+	++	++
*N 4	+	o	o	o	o	o	o	o	o	o	o	o	c	c

* Naso-pharyngeal strain, see p. 147.

The results obtained are remarkable. In the first place, as might have been expected, the related strains of the previous group A 13 and C.S. 4, as well as the strain A 23, which agglutinated to the full titre with serum A 10 (*vide* Table I), all absorb completely, or almost completely, the agglutinin for the homologous strain. This confirms the deduction drawn from Table VII, namely, the close relationship of these four strains. Of the other strains employed, C.S. 1, a typical main Group I strain, and A 1 and A 2, allied to but not identical with this main group, all fail to absorb more than small amounts of the A 10 agglutinin. A 1, however, absorbs a marked amount of the agglutinin for the strain A 13, as also does A 16, which is another unidentified ally of the main Group I. These two, then, though only distantly related to A 10, have a connecting relative in the strain A13.

Strains C.S. 16, C.S. 14, and A 24, on the other hand, are definitely members of Group II, being agglutinated strongly by the main Group II serum and not at all by the main Group I, while the sera they produce by injection into animals agglutinate Group II strains to a high titre and Group I strains slightly, if at all. Yet C.S. 16 absorbs the A 10 agglutinin almost, if not quite, as well as the strains C.S. 4, A 13, and A 23, which have been put down as closely related to A 10, while A 24 absorbs only a small amount of A 10 agglutinin and C.S. 14 almost none.

This is a case in which agglutination reactions evidently fail to agree with the results of absorption, since strain C.S. 16 agglutinates with A 10 serum up to 1-500 only (*vide* Table I), a level which is reached also by most of the strains in Table VII which show feeble, if any, absorption.

For the present, until the absorption results with the Group II sera have been discussed, it will be better simply to note this anomaly, without trying to explain it. But it may be observed at this point that the sera P 1, A 17, and C.S. 8, behave very differently from serum A 10 in the sharpness with which absorption differentiates individual strains. The former three either show practically complete absorption or practically none, whereas A 10 serum gives all degrees of absorption with different strains. Further, as has been noted, in the case of the former sera increase in the amount of bacterial protein used for absorption does not increase the amount of agglutinin removed by the poor absorbers. With serum A 10 increase in the amount of culture to 80 mg. per c.c. of 1-50, or repeated addition of smaller amounts, increases the amount of absorption in the case of certain strains, *e.g.*, A 24, but not in others, *e.g.*, C.S. 14. This quality is characteristic of two of my Group II sera.

The strain A 10 is one of those given me by Dr. Arkwright. It came from one of the first cases in the epidemic which broke out among Canadian troops in this country, and has been described already by Dr. Arkwright* under the name of "Murray"; in his description he records that it belonged serologically to the meningococcus species, and not to the parameningococcus of Dopter. Translated into the terms of my classification, this

* British Medical Journal, 1915, Vol. II., p. 885.

means that it belonged to Group I, and not to Group II. In my hands, although it inclines to the main Group I on its agglutination reactions, and is linked up to it by the relations shown by absorption, it has evidently affinities in addition which connect it with Group II.

There are thus several considerations all leading to the conclusion that A 10, whether originally or as the result of subsequent variation, lies intermediate between the main Group I and the main Group II, for

(1) it agglutinates equally, though relatively feebly, with the sera of both groups;
(2) it does not absorb agglutinin from either of the two main group sera, but
(3) the serum which it produces agglutinates indifferently, though weakly, strains of both main groups, and
(4) picks out, as agglutinating to high titre, a strain allied to Group I, (A 13), and also one allied to Group II; while
(5) its agglutinin is absorbed both by strains allied to Group I and by at least one typical Group II strain; and
(6) the behaviour of the serum on absorption with different quantities of culture resembles that of other sera prepared with Group II strains.

Sub-Group (4).

Example of an aberrant type.

The absorption tests with serum A 2 may be summed up shortly without a table. None of the other spinal strains absorb more than small amounts of A 2 agglutinin, even when added in great excess, and the Group II strains in particular are completely devoid of absorptive capacity; indeed, after absorption with large amounts of these the titre of the "absorbed" serum appears slightly higher than before, the agglutination in the highest dilutions being more complete. Strain A 2, therefore, remains alone among my known pathogenic strains as the type of its sub-group, but it will be seen later that this sub-group is well represented among naso-pharyngeal meningococci.

As has been noted. it agglutinates indifferently with sera of both Group I and Group II, but to a low titre with both. It absorbs small amounts of agglutinin from certain Group I sera, but none, or practically none, from the Group II. It has, therefore, been put among the strains which lean towards the main Group I. With strain A 2 a serum of high titre was obtained after prolonged immunisation, agglutinating it completely at 1-1,500. No other strain was agglutinated to the same level with this serum, but among spinal strains one, B 12, gave almost complete agglutination at 1-1,000; two strains, C.S. 4 and A 13, which belong to one group, as has been seen, were agglutinated completely at 1-500, while C.S. 20, belonging to another group, and A 15, which was identified with the main Group I, almost reached the same titre. The others of the main Group I gave complete agglutination at 1-100, but only traces of agglutination at 1-500. The Group II

strains were either completely negative, or gave only traces of agglutination at 1-100.

The agglutinogenic characters of A 2 thus confirm in the main its position as allied to Group I, but show that it possesses a pronounced individuality, distinguishing it from all the other spinal strains in my possession.

Absorption tests with serum A 2 confirm its peculiarities; none of the spinal strains, not even those agglutinating relatively well, remove any but the merest traces of the homologous agglutinin, although removing all the agglutinin for themselves. It must be noted further that the other strains hitherto unidentified, strains A 1, A 16, B 12, B 1, B 3, B 5 and B 10, fail to disclose definite relationship with A 2 as the result of application of its serum.

These strains may resemble A 2 in possessing serological properties peculiar to each, or they may belong to entirely different groups. It would be necessary, in order to settle more definitely their relationship, to investigate their agglutinogenic action, but even this, as has been seen in connection with A 2, and as will be seen with the naso-pharyngeal strains, might leave the question in doubt.

Sub-Group (5).

The three strains placed together in this sub-group are those which, though showing by their agglutination that they incline definitely towards the main Group I, all fail to absorb more than small amounts of agglutinin from the sera of this main group and the sub-group sera. Two of them, however, have been identified by absorption tests with a naso-pharyngeal strain which itself is similarly inclined to the main Group I, but also fails to absorb. This sub-group (5), then, seems to consist of two sub-groups, the second consisting solely of the strain B 12, which, like A 2, is highly individual in its characters.

Main Group II.

The results of absorption with the main Group II serum, P 2, as has been mentioned, have not the uniformity which is typical of the main Group I. In Table IX, subjoined, an example is given of the irregularity often met with. The quantity of culture employed in each case was 15 mg. for each c.c. of 1-50 dilution of the serum; this is the minimum for complete absorption of agglutinin by the homologous strain for itself, but does not reach the minimum which certain strains require to remove completely the agglutinin, either for themselves or for the homologous strain. Hence some of the strains in this table which fail to remove the agglutinin completely appear as incomplete absorbers only because, not 15 mg., but, say, 30 mg., of culture were required to complete the removal.

TABLE IX.

Absorption of agglutinin from serum P 2.

Serum.	Agglutination with Homologous Strain P 2.					Agglutination with Related Strain C.S. 14.					Absorption of Agglutinin for Homologous Strain P 2.	Absorption of Agglutinin for Strain C.S. 14.
Control Unabsorbed.	100 c	600 c	1000 c	1400 c	2000 + + +	100 c	600 c	1000 c	1400 c	2000 + + +		
Absorbed by Strain.												
(1) C.S. 1 ...	c	c	c	c	+	c	c	c	+ + +	o	trace ?	+
(2) C.S. 17 (1)	c	c	c	c	+	c	c	c	+	o	trace ?	+
(3) C.S. 25 ...	c	c	c	c	+ + +	c	c	c	+ + +	o	o	+
(4) C.S. 8 ...	c	c	c	c	+ + +	c	c	c	c	+ +	o	o
(5) C.S. 20 ...	c	c	c	c	+ +	c	c	c	+ +	+	o	+
(6) C.S. 4 ...	c	c	c	c	+ +	c	c	c	+ +	+	o	+
(7) A 23 ...	c	c	c	+ +	+	c	c	+ +	+	o	+	+ +
(8) A 16 ...	c	c	c	c	+	c	c	c	+ + +	o	trace ?	+
(9) B 1 ...	c	c	c	+ + +	+	c	c	+ +	+	o	+	+
(10) B 3 ...	c	c	c	c	+ +	c	c	c	c	+ +	o	o
(11) B 5 ...	c	c	c	c	+	c	c	c	o	o	trace ?	+
(12) B 10 ...	c	c	c	c	+ +	c	c	c	c	+ +	o	o
(13) A 10 ...	c	c	c	+ + +	+	c	c	+ +	+	o	+	+
(14) A 24 ...	c	+ + +	+ +	o	o	+	o	o	o	o	+ + +	c
(15) A 22 ...	c	+ +	o	o	o	o	o	o	o	o	+ + +	c
(16) C.S. 9 ...	c	+ + +	o	o	o	+ + +	o	o	o	o	+ + +	c
(17) C.S. 10 ...	+ + +	+	o	o	o	o	o	o	o	o	c	c
(18) C.S. 11 ...	c	+ +	o	o	o	o	o	o	o	o	+ + +	c
(19) C.S. 12 ...	c	+	o	o	o	o	o	o	o	o	+ + +	c
(20) C.S. 14 ...	c	c	+ + +	+ +	o	o	o	o	o	o	+ +	c
(21) C.S. 15 ...	+ +	+	o	o	o	o	o	o	o	o	c	c
(22) C.S. 16 ...	o	o	o	o	o	o	o	o	o	o	c	c
(23) C.S. 17 (2)	c	c	+ + +	+ +	+	c	c	c	+ + +	+	+ +	+
(24) C.S. 19 ...	c	c	+ + +	+ + +	+	+ +	o	o	o	o	+ +	c
(25) C.S. 22 ...	+ +	o	o	o	o	+ + +	o	o	o	o	c	c
(26) C.S. 26 ...	+ + +	+	o	o	o	+	o	o	o	o	c	c
(27) A 20 ...	+ + +	+ +	o	o	o	+	o	o	o	o	c	c
(28) A 25 ...	c	c	+ + +	+	o	+ +	o	o	o	o	+ +	c
(29) B 4 ...	c	+ + +	+	+	o	c	+ +	o	o	o	+ + +	+ + +
(30) B 6 ...	c	+ + +	o	o	o	c	+	o	o	o	+ + +	+ + +
(31) B 7 ...	+ + +	+	o	o	o	+ + +	+	o	o	o	c	c
(32) B 8 ...	c	+ +	o	o	o	c	+	o	o	o	+ + +	+ + +
(33) B 9 ...	+ +	+	o	o	o	c	+	o	o	o	c	+ + +
(34) B 11 ...	c	+ +	o	o	o	c	+	o	o	o	+ + +	+ + +
(35) P 2 ...	+ +	+	o	o	o	+	o	o	o	o	c	c

But it will be seen that those strains, numbers (1) to (7), which have already been identified with other groups are in agreement in removing traces at most of the homologous agglutinin. Similarly, four of the five strains which, in Table I, were shown to agglutinate feebly with all the sera, and were hence not capable of classification (Nos. 9, 10, 11, 12 here), fail to absorb definite amounts of agglutinin.

On the other hand, of the twenty strains put in the main Group II on the strength of agglutination, eight give absorption equal, or almost equal, to the homologous strain, nine give absorption just short of complete, while three give definite absorption but leave intact perhaps half the agglutinin for the homologous strain.

Of these three partial absorbers one agglutinates to full titre with serum P 2, while two agglutinate completely at 1-1,500 (*vide* Table I).

Some indication of subgrouping within Group II appears on inspection of the column recording absorption of agglutinin for C.S. 14. This strain is itself one of the partial absorbers although a good agglutinator; if, in serum P 2, the agglutinin responsible for the agglutination of C.S. 14 were in some way different from the main agglutinin produced by P 2, then strains which differed from P 2 in the same way as C.S. 14 does, ought to remove completely the agglutinin for C.S. 14, but to a varying and less extent for P 2. And, in fact, strain C.S. 19, which absorbs P 2 agglutinin only " + + ", absorbs C.S. 14 agglutinin completely, while many of the strains absorbing P 2 just short of completely, remove all the agglutinin for C.S. 14.

The indication is that C.S. 14 is allied to C.S. 19, and that both differ slightly from P 2 and most of the other strains, but the evidence is slender, as will be seen later.

One strain removes agglutinin only partially for both C.S. 14 and P 2; this is C.S. 17 (2), the variant of the Group I strain, C.S. 17, already referred to as having changed its character. One strain, B 8, which, on agglutination, appeared a doubtful adherent of Group II, is shown by absorption to be closely allied to, if not identical with, the main group.

The absorptive action of strains C.S. 14, C.S. 16 and A 24 should be specially noted, as sera have been prepared with them, the behaviour of which will be recorded below. Of these C.S. 16 and A 24 are good absorbers, while C.S. 14, as just remarked, is a partial absorber.

In Table X are given the results of absorption from serum C.S. 14, the quantity of culture used being 10 mg. per c.c. of 1-50 serum dilution.

TABLE X.

Absorption of agglutinin from serum C.S. 14.

Serum.	Agglutination with Homologous Strain C.S. 14.				Agglutination with Related Strain P 2.				Absorption of Agglutinin for Homologous Strain C.S. 14.	Absorption of Agglutinin for Strain P 2.
Control Unabsorbed.	100 c	500 c	1000 c	1500 c	100 c	500 c	1000 c	1500 c		
Absorbed by Strain.										
C.S. 1 ...	c	c	c	+ +	c	c	c	+ + +	trace.	trace ?
C.S. 17 (1)..	c	c	c	c	c	c	c	c	o	o
C.S. 8 ...	c	c	c	c	c	c	c	c	o	o
C.S. 4 ...	c	c	c	+ + +	c	c	c	+ +	trace ?	trace.
A 23 ...	c	c	+ + +	+	c	c	c	c	+	o
B 1 ...	c	c	+ + +	+	c	c	+ +	+	+	+
B 3 ...	c	c	c	c	c	c	c	+ + +	o	trace ?
A 10 ...	c	c	+ + +	+	c	c	c	c	+	o
A 24 ...	o	o	o	o	o	o	o	o	c	c
A 22 ...	+	o	o	o	o	o	o	o	c	c
C.S. 9 ...	+	o	o	o	o	o	o	o	c	c
C.S. 10 ...	+ +	o	o	o	c	o	o	o	c	+ + +
C.S. 11 ...	o	o	o	o	o	o	o	o	c	c
C.S. 12 ...	+ + +	+ + +	+	o	+ +	+	o	o	c ?	c
C.S. 14 ...	o	o	o	o	+	o	o	o	c	c
C.S. 15 ...	+	o	o	o	o	o	o	o	c	c
C.S. 16 ...	+ +	o	o	o	o	o	o	o	c	c
C.S. 17 (2)...	c	+	o	o	+ + +	o	o	o	+ + +	c
C.S. 19 ...	+ + +	o	o	o	o	o	o	o	c	c
C.S. 22 ...	+	o	o	o	o	o	o	o	c	c
C.S. 26 ...	+	o	o	o	o	o	o	o	c	c
A 20 ...	o	o	o	o	o	o	o	o	c	c
A 25 ...	o	o	o	o	o	o	o	o	c	c
P 2 ...	o	o	o	o	o	o	o	o	c	c

In the first place it may be noted that the first five strains, which belong to Group I, absorb, at most, traces of agglutinin, as do also the next two strains, B 1 and B 3, which were doubtful adherents of Group II. Strain A 10, the strain intermediate between the two groups, also removes only a minute amount of C.S. 14 agglutinin.

On the other hand fifteen strains, which by agglutination were put in Group II, absorb all or almost all the agglutinin both for C.S. 14 and for P 2, the type strain of Group II. Among these are C.S. 19 and C.S. 17 (2) which showed only partial absorption with P 2 serum (*vide* Table IX).

No well-marked difference can be detected between the absorption of agglutinin for the homologous strain C.S. 14 and that for the type strain P 2.

In Table XI are given the results of absorption from serum C.S. 16 by a selection of Group II strains, with, as controls, three strains more closely allied to Group I and the four strains which, on agglutination, were referable to neither group but inclined, perhaps, to Group II.

TABLE XI.

Absorption of agglutinin from serum C.S. 16.

Serum.	Agglutination with Homologous Strain C.S. 16.				Agglutination with Related Strain A 22.				Absorption of Agglutinin for Homologous Strain C.S. 16.	Absorption of Agglutinin for Strain A 22.
Control Unabsorbed.	100 c	400 c	800 c	1200 c	100 c	400 c	800 c	1200 c		
Absorbed by Strain.										
C.S. 20 ...	c	c	c	c	c	c	c	c	o	o
A 13 ...	c	c	c	c	c	c	c	c	o	o
A 10 ...	c	c	c	c	c	c	c	c	o	o
A 24 ...	+ + +	+	o	o	+ +	+	o	o	c	c
C.S. 10 ...	+ + +	+	o	o	+	o	o	o	c	c
C.S. 14 ...	+ + +	+	o	o	+ +	o	o	o	c	c
C.S. 16 ...	+ +	o	o	o	+	o	o	o	c	c
C.S. 19 ...	+ + +	+	o	o	+ +	o	o	o	c	c
A 20 ...	+ + +	+	o	o	+ + +	o	o	o	c	c
A 25 ...	c	+ + +	o	o	+ + +	+	o	o	+ + +	c
B 1 ...	c	c	c	+ + +	c	c	c	c	trace ?	o
B 3 ...	c	c	c	c	c	c	c	+ + +	o	trace ?
B 4 ...	+ + +	o	o	o	+	o	o	o	c	c
B 5 ...	c	c	c	+ + +	c	c	c	c	trace ?	o
B 6 ...	c	o	o	o	+	o	o	o	+ + +	c
B 7 ...	+ + +	o	o	o	+	o	o	o	c	c
B 8 ...	o	o	o	o	trace	o	o	o	c	c
B 9 ...	c	o	o	o	+	o	o	o	+ + +	c
B 10 ...	c	c	c	c	c	c	c	c	o	o
B 11 ...	c	o	o	o	+	o	o	o	+ + +	c

It will be seen that all these controls absorb, at most, traces of agglutinin for both the test emulsions, while the strains already put in Group II absorb the agglutinin for both, either completely or almost completely. It is worth noting that strain A 10 which, as was seen in Table VIII, produced a serum from which C.S. 16 absorbed practically all the agglutinin, fails entirely to absorb agglutinin from C.S. 16 serum; on repeating this absorption test with A 10 on C.S. 16 serum, but using 60 mg. of culture per c.c. in three instalments of 20 mg. instead of 10 mg. in all, the negative result persisted, as was the case also with strains C.S. 20 and A 13 similarly tested.

Sub-Group (6).

Finally the results of absorption of agglutinin from serum A 24 may be given (Table XII). Strain A 24. as has been remarked, (*vide* Tables I, IX, X, and XI) agglutinated to the full titre with all the Group II sera and absorbed their agglutinin completely, but the agglutination reactions of the serum it produced indicated that it possessed peculiar characters, not revealed by these sera, since only one of the other Group II strains appeared to be specifically affected.

The technical details of the experiment are as before, but the symbols have been given a higher value in consequence of the low titre of the serum, complete absorption being presumably easier from a weak serum.

TABLE XII.

Absorption of agglutinin from serum A 24.

Serum.	Agglutination with Homologous Strain A 24.				Agglutination with Related Strain A 22.				Absorption of Agglutinin for Homologous Strain A 24.	Absorption of Agglutinin for Strain A 22.
Control Unabsorbed	100 c	400 c	800 c	1000 c	100 c	400 c	800 c	1000 c		
Absorbed by Strain.										
C.S. 9 ...	+ + +	+ + +	+ +	o	c	+ + +	o	o	+ +	+ +
C.S. 11 ..	+ +	trace	o	o	+ +	o	o	o	c	c
C.S. 22 ..	c	c	c	c	c	+ + +	o	o	o	+ +
C.S 14. ..	c	c	c	c	c	+ + +	trace	o	o	+ +
A 22 ...	o	o	o	o	o	o	o	o	c	c
A 24 ...	o	o	o	o	o	o	o	o	c	c
A 25 ...	c	c	+ + +	+ + +	c	+ + +	o	o	+	+ +
P 2 ...	c	c	c	c	c	c	+ + +	o	o	+

The peculiar characters of A 24 and A 22 are confirmed by the absorption test and justify the position of these two strains as forming a sub-group within the main Group II. The strain A 22, which, as was shown in Table I, was unique in reaching the full titre for this serum, removes, as might be expected, all the agglutinin for A 24, while one other strain, C.S. 11, which agglutinated with A 24 serum up to 1-500 only, absorbs almost all the agglutinin for both A 24 and A 22. Strain C.S. 9, which also agglutinated up to 1-500, absorbs perhaps half the agglutinin, while C.S. 22, which had the same agglutination titre, absorbs none of the A 24 agglutinin and only a small amount of that for A 22.

The type strain, P 2, absorbs none of the A 24 agglutinin, in spite of the fact that A 24 absorbs the P 2 agglutinin from P 2 serum almost completely.

Sub-Group (7).

The Sub-Group (7) which was created on the strength of agglutination results and recorded in Table III has by the use of the absorption test had its numbers reduced from five to four, since the strain B 8 although agglutinating relatively feebly has been shown to absorb all the agglutinin from serum C.S. 16. The other four strains, however, remain as a sort of scrap-heap since though they certainly agglutinate rather better with the Group II sera than with Group I yet their agglutination can in no case be said to be decisive, and they absorb practically none of the various agglutinins tested. They may belong to one group or may each represent strains of high individuality; they may be compared in this respect to the strain A 2 and may bear the same relation to the main Group II that this strain has shown towards the main Group I.

General Behaviour of Group II sera on absorption.

The results of absorption from the Group II sera are evidently much more complicated and difficult to explain than those with the Group I sera.

In the first place there is the phenomenon, which was noted in connection with serum A 10, that increase in the amount of culture used for absorption may transfer a strain from the category of poor absorbers into that of complete absorbers. This is even more marked in the case of the Group II sera P 2 and C.S. 14. For example, with serum P 2 in one absorption experiment, using 8 mg. of culture per c.c. of 1-50 dilution, the homologous strain P 2 and strains C.S. 16, A 22, C.S. 22, out of fifteen Group II strains, were the only ones which reduced the titre to just below 1-500; with C.S. 9, C.S. 10, C.S. 11, C.S. 12, A 20, A 24, A 25, C.S. 14 and C.S. 19 the titre was reduced to incomplete at 1-1,000 only; on repeating the extraction with the same amount of culture on the partially exhausted serum, the titre was reduced somewhat below the levels shown in each case in Table IX, *e.g.*, with P 2, the homologous strain, only traces of agglutination persisted at 1-100, as also with A 22, C.S. 22, C.S. 10, C.S. 11, C.S. 12 and A 20, while with C.S. 9, A 24, A 25 and C.S. 14 agglutination was still complete at 1-100 but incomplete at 1-500. If an arbitrary point had been chosen as determining a positive result, as, for example, complete or incomplete agglutination at 1-500, this dilution only being tested, and if the test had been performed only after the first extraction, very definite grouping might have appeared, P 2, C.S. 16, A 22, C.S. 22 forming one group among the Group II strains, while the others might have been regarded as doubtful allies. When more opportunity for absorption was provided by increasing the amount of extracting material, the results, as shown in Table IX, indicate that many more strains are capable of removing completely, or almost completely, the homologous agglutinin.

Exactly similar results have been obtained with serum C.S. 14; as with serum P 2, increase in the amount of culture used in the absorption test broadened the selective action of the agglutinin to a quite remarkable extent.

This behaviour makes it extremely difficult to use the absorption test in estimating the relationships of the different strains of Group II. Some indication of the presence of sub-groups is to be found in the relative ease with which certain strains remove agglutinin as compared with others, but it is very doubtful if any stress can be laid on this, since, if all the agglutinin in the test serum can be combined and removed by a strain, even though large quantities of culture are necessary, the negative controls remaining unaffected, it shows, at least, that the partial absorption given by the smaller amount does not depend on the presence in the serum of an anti-body which fits the homologous and identical strains but does not fit those absorbing less readily. And the demonstration of an anti-body which is incapable of absorption by non-identical strains is the admitted criterion in distinguishing "specific" from "group" agglutination.

Yet the existence in the Group II sera of such "group" agglutinins would seem to be demanded by the fact that they agglutinate and are absorbed to a small extent by strains such as those of the main Group I and some of its allies. The difference is that increase in the amount of culture used does not lead with these, as with the less active absorbers among Group II strains, to increased absorption. These strains which fail to absorb even when present in great excess act as controls to show that in the action of large amounts of culture physical non-specific destruction of agglutinin is not responsible for absorption.

On what, then, depends the less easy absorption by strains which, in actual bio-chemical constitution, are apparently identical with the strain producing the serum?

To answer this would require a much more profound knowledge than is in existence of the factors at work in the absorption test, and it has not been found practicable at this time to investigate these factors as a problem apart from the classification of pathogenic meningococci and the identification of nasopharyngeal strains with them.

The following considerations may apply. The absorption of agglutinin by a suspension of bacteria may be conceived as a simple chemical combination, each coccus, for example, being capable of combining with a certain definite maximum of the protein in the serum which carries the agglutinating property. This maximum might vary in different strains, so that a strain in which it was high would remove more agglutinin for a given number of cocci than another in which

it was low, although the qualitative nature of the chemical action taking place did not differ. This supposition would account for most of the phenomena in the absorption tests with Group II strains, were it not for the difficulty caused by the fact that a strain may have a low maximum with one serum and a high maximum with another, though capable of removing all agglutinin from both.

An alternative conception depends on the phenomena observed in biological precipitation. When, for example, dilute horse serum is mixed with the serum of a rabbit immunized against horse protein, a bulky precipitate is thrown down, by far the greater part of which is derived, not from the dilute horse serum, the precipitinogen, but from the anti-serum, the precipitin. The same observation has been made with bacterial precipitation, such as occurs when a filtered extract of bacteria has been brought in contact with the corresponding anti-serum. Here the amount of the bacterial protein has no direct relation with the amount of protein thrown out of solution and removed from the anti-serum.

There is considerable evidence that bacterial precipitin and bacterial agglutinin are attached to one and the same protein in the anti-serum, but, even if attached to different proteins, the production of a precipitin—precipitum in the mixture would necessarily produce a mechanical agglomeration and deposit of the suspended cocci which would both simulate and take part in the total agglutination. Hence, supposing, as seems reasonable, that dissolved bacterial proteins, as well as intact cocci, are present in the suspensions, then not only agglutination but removal of agglutinin would depend both on deposition of cocci which had combined with agglutinin and on the precipitation of large quantities of anti-body in consequence of the presence of dissolved bacterial protein acting as a precipitinogen.

Hence one might account for the different behaviour of Group I and Group II strains in absorption tests by supposing that Group I strains more readily liberate their protein into solution, so that more of this second method of removing anti-body occurs ; while Group II strains might depend for agglutination and for agglutinin-absorption on the much less powerful action of direct combination of cocci with agglutinin.

I have some evidence that suspensions of those strains which remove agglutinin on the addition of small amounts of culture contain more detached soluble protein than those which require large amounts, since I have repeatedly seen with Group I strains, as contrasted with Group II strains in which the phenomenon is much less marked, that when a suspension of culture has been freed from all intact cocci by the centrifuge or prolonged standing, or by filtration, the clear liquid produces almost as large a precipitum with the anti-serum as the same fluid containing the suspended cocci ; this precipitum must consist chiefly of the anti-body present in the serum, the removal of which probably depends on the precipitinogen contained in the dissolved bacterial protein and is thus governed by laws different from those ruling the absorption by intact cocci.

On this hypothesis, then, the different behaviour of certain strains and sera as regards the facility of absorption would be explained by the varying amount of dissolved protein present in the suspensions—(this would explain also the difference between individual Group II strains). A correlated factor may be the varying extent to which anti-body capable of behaving like precipitin is present in the serum—(this would still further explain the difference in behaviour between sera which respond to increase of culture by increase of absorption and those which do not).

But in reviewing generally the difficulties in reconciling the different behaviour of meningococcus strains and anti-sera, I can only repeat that, until the essential nature is known of the physico-chemical action which results in absorption of agglutinin, there is little probability of satisfactorily explaining the apparent anomalies.

Two of these anomalies, which have been specifically mentioned and are of similar character, are (1) the fact that strain A 24 absorbs completely from serum C.S. 14 the agglutinin for C.S. 14, while C.S. 14 removes none of the specific agglutinin for A 24 from serum A 24, and (2) that strain C.S. 16 removes all, or nearly all, the specific agglutinin for strain A 10 from serum A 10, but strain A 10 removes little or none from serum C.S. 16.

It is just possible that the specific agglutinin in A 24 serum consists almost entirely of very specialized anti-bodies, corresponding to very specialised antigens in strain A 24 and hence not affected by strain C.S. 14, while in serum C.S. 14 the anti-bodies present are of a more general character, each antigen in the strain

having exerted an approximately equal effect on the animal. In the absorption of serum C.S. 14 by A 24 the antigens of general Group II character alone come into action, and the more special C.S. 14 anti-bodies, if any, are in such small amount that, though left in the serum after absorption by A 24, they only produce agglutination of low titre for C.S. 14.

A similar explanation in the other case meets with the difficulty that serum A 10 undoubtedly contains very special anti-bodies of predominating Group I character as well as the more general, and it is hard to conceive that strain C.S. 16 which, agglutinogenically, had little relation to A 10, contained enough of the special corresponding antigen to affect these appreciably, whereas serum C.S. 16 resembles very much serum C.S. 14 and would, therefore, contain special anti-bodies in less amount than the more general anti-bodies; it should hence be be affected appreciably by contact with the general antigens of A 10.

The only explanation possible is that strain C.S. 16 at the time it was used for absorption had become modified in character, acquiring some of the characters more typical of A 10. That such modification may occur is to my mind probable, and the following section records variations in specific character as determined by absorption tests.

Variations in absorptive quality and capacity.

Variations in agglutinability have already been noted and illustrated in Table II. In particular, one strain, C.S. 17, was stated to have changed from agglutination to full titre with Group I serum when first isolated to agglutination to full titre with Group II serum after keeping in culture for a month, the other group serum in each case being almost if not quite negative. One month later it again agglutinated to full titre with the Group I serum and only slightly with Group II. This latter condition has persisted unchanged now for several months, but another sub-culture from that which gave Group II agglutination has remained equally definitely of Group II character in agglutination; the former I have designated C.S. 17 (1), the latter C.S. 17 (2). Both have been plated out at intervals of about a month and have given on each of three occasions practically pure cultures of their own agglutinating type, four colonies being investigated from each plate. One colony from C.S. 17 (2), however, agglutinated to 1-500 with serum P 1, the Group I serum, as well as to full titre with serum P 2, the Group II serum, and therefore might be regarded as tending towards an intermediate position.

From the Group I sera P 1 and A 17 the strain C.S. 17 (1) absorbs practically all the agglutinin for the homologous strains as for itself, while C.S. 17 (2) removes none either for the homologous strains or for C.S. 17 (1). From the Group II sera P 2 and C.S. 14 the strain C.S. 17 (1) absorbs no agglutinin either for the homologous strains or for C.S. 17 (2), whereas the latter absorbs rather less than half the agglutinin for the homologous strains (noted as + +), but all the agglutinin for itself.

From serum C.S. 8 both C.S. 17 (1) and C.S. 17 (2) remove no agglutinin for the homologous strain, but C.S. 17 (1) removes all the agglutinin for itself (titre before absorption 1-500), while C.S. 17 (2) leaves the agglutinin for C.S. 17 (1) intact.

From serum A 10, C.S. 17 (1) removes agglutinin entirely for itself, and " + + " for the homologous strain, while C.S. 17 (2) removes none of either agglutinin.

The absorption tests thus confirm the Group I condition of C.S. 17 (1), but leave doubtful the exact position of C.S. 17 (2); yet by agglutination this strain is definitely of Group II, and this is confirmed by its agglutinogenic action, since a serum prepared with C.S. 17 (2) agglutinated all the Group II and left practically unaffected the Group I strains.

The conclusion to be drawn is either that this strain C.S. 17 changed its serological character entirely during cultivation, or that in the original infection two strains of meningococci were present, one or other predominating at different times during cultivation until in separate instances one or other died out entirely. On the whole I feel inclined to take the latter view, but have felt bound to record the occurrence as a possible instance of profound variation in the serological character of a meningococcus strain.

Strain A 24 has been particularly variable in the extent of its absorbing powers for certain sera. At one time 10 mg. of its culture removed only traces of the homologous agglutinin from serum P 2, while three months later the same quantity removed all the homologous agglutinin, although in the two cases the cultures were equally well agglutinated by serum P 2. But even with its own serum such irregularities in absorptive power appeared. Sub-cultures from two colonies on the same plate differed entirely in their absorptive power, one removing all the A 24 agglutinin, while the other barely affected this serum, although again both agglutinated well. On the other hand, with serum C.S. 16, these two colonies, though differing markedly in agglutinability, one being complete at 1-1,500, while the other did not agglutinate above 1-100, absorbed the C.S. 16 agglutinin completely in both instances.

Strain C.S. 16 absorbed from serum A 10 on November 11th, 1916, only traces of agglutinin, whereas later, on February 21st, 1917, it absorbed A 10 serum completely, although used in exactly the same amount and under the same conditions.

Finally, the strain C.S. 10 may be mentioned. In July, 1916, it absorbed C.S. 14 serum completely as it did again in August, but in November it had become much less agglutinable and also failed entirely to absorb C.S. 14 agglutinin. Since then it has remained inagglutinable with all the sera tested and removes no agglutinin from any of the Group II sera. Morphologically and culturally it is unchanged.

Explanation of Serological Differences.

Before proceeding to discuss the naso-pharyngeal strains it may be well at this point to summarise my argument as to the reason for the differences found by serological tests in different strains of meningococci obtained from spinal fluid, leaving over for the moment the question of the validity of these differences as criteria for classification into fixed types.

I have concluded, then, that peculiarities in the protein molecule affect the antigenic action of the different strains and excite in the immunised animal the production of anti-bodies of similar peculiarity, that in some strains, *e.g.*, those within or allied

to Group I, this particularisation of the protein molecule is much more advanced than in others, *e.g.*, Group II; in the former, serological identity is much more striking when it appears and serological difference is similarly more obvious, while in the latter the peculiar properties are in the background, and the general action of the protein as antigen and combining factor in serological reactions is more pronounced, so that peculiarities in the strains belonging to this group are readily concealed by the interaction of their more general characters. It is probable that peculiarities limited to small sub-groups of strains, or even to individuals, also exist in Group II, but, as a result of this quantitative difference in particularisation, the sub-groups among the former are well marked, while in the latter they are submerged in the general character of the large group.*

These conclusions certainly seem to explain the experimental facts. The question remains whether these peculiarities are permanent features of the strains or only temporary, however strong they may be. Possibly they have been acquired during a long process of evolution, and hence deserve consideration as stages in the direction of specific differentiation; or they perhaps merely express variations recently acquired as the result of interaction with the tissues of their host.

Unfortunately, conclusive evidence on these points is extremely difficult, if not impossible, to get. In artificial culture the variations which I have been able to demonstrate are not conclusive evidence that in nature change can take place from one group to another, and are open to the objection that the original strain may not have been pure but contained two varieties existing side by side, but predominating at different times.

The relative proportions of the different types isolated from the human host in health and disease are, however, somewhat suggestive of modification due to environment, and this question will be referred to again when the serological reactions of naso-pharyngeal strains have been discussed.

Naso-pharyngeal Strains.

As has already been indicated, these strains were isolated from naso-pharyngeal mucus, and each represents a colony found on plates of Kutscher's medium inoculated with this material. Morphologically and culturally they were indistinguishable from the meningococci isolated from cerebro-spinal fluid in cases of the specific disease. Sixteen represent the survivors of the thirty strains from Lambeth outpatients discussed in my former report; the remainder, making up the total of seventy-one, were isolated during the first half of 1916, chiefly from soldiers in camp or garrison.

* This difference between the groups may depend, however, on the accident of choice of strains used for producing sera; it seems possible that, with a different selection, sera of Group I might be found containing agglutinins in large amounts for its sub-groups, and sera of Group II (cf. serum A 24) containing agglutinins acting only on small sub-groups.

Agglutination and Absorption Reactions.

In the following table (Table XIII) the dilutions are given at which complete agglutination was produced by the two sera, C.S. 14 and C.S. 16, with all the naso-pharyngeal strains in my possession. These sera were both prepared with strains of pathogenic origin, both belonging to Group II; the titre for the homologous strain was in each case 1-1500. In the same table the results of absorption of the agglutinin for the homologous strains are given for these two sera, using 10 mg. of culture with each strain for 1 c.c. of the serum diluted 1-50; the symbols have the same value as in the previous absorption tables for these sera (Tables X and XI).

TABLE XIII.

Naso-pharyngeal strains: Results of agglutination and absorption with two Group II spinal sera.

Strain.	Agglutination with Serum C.S. 14.	Agglutination with Serum C.S. 16.	Absorption from Serum C.S. 14.	Absorption from Serum C.S. 16.	Strain.	Agglutination with Serum C.S. 14.	Agglutination with Serum C.S. 16.	Absorption from Serum C.S. 14.	Absorption from Serum C.S. 16.
N 1 ...	100	100	tr.	tr.	N 37 ...	100	500	o	+
N 2 ...	tr.	tr.	tr.	tr.	N 38 ...	1500	1500	c	c
N 3 ...	tr.	100	tr.	tr.	N 39 ...	1500	1500	c	c
N 4 ...	100	100	+	tr.	N 40 ...	1500	1000	c	c
N 5 ...	100	500	+	+	N 41 ...	1500	100	c	c
N 6 ...	1500	1000	c	c	N 42 ...	1000	1000	+ + +	c
N 7 ...	tr.	100	tr.	tr.	N 43 ...	1500	1500	c	c
N 8 ...	o	100	tr.	tr.	N 44 ...	1500	1500	+ + +	+ + +
N 9 ...	1500	1000	c	+ + +	N 45 ...	1500	1500	c	c
N 10 ...	tr.	100	tr.	o	N 46 ...	1500	1500	c	
N 11 ...	tr.	o	o	o	N 47 ...	1000	1500	+ + +	c
N 12 ...	tr.	100	o	o	N 48 ...	100	100	+	o
N 13 ...	100	100	+ +	+	N 49 ...	100	100	o	+ +
N 14 ...	tr.	o	o	o	N 50 ...	1000	1000	c	c
N 15 ...	1500	100	+ + +	+ +	N 51 ...	1500	1500	c	c
N 16 ...	tr.	100	+ +	+	N 52 ...	1000	1000	c	c
N 17 ...	500	1500	+ + +	+	N 53 ...	o	o		o
N 18 ...	100	100	+	o	N 54 ...	1000	1500	c	
N 19 ...	o	o	o	o	N 55 ...	1500	1500	+ + +	c
N 20 ...	100	100	tr.	o	N 56 ...	1000	1500	c	+ + +
N 21 ...	1500	1000	c	+ + +	N 57 ...	1500	1500	c	
N 22 ...	1000	1500	c	c	N 58 ...	o	100	tr.	+
N 23 ...	tr.	o	tr.	tr.	N 59 ...	1500	500	c	c
N 24 ...	100	100	+		N 60 ...	1500	1500	c	c
N 25 ...	1500	1500	c		N 61 ...	1500	1500	c	c
N 26 ...	100	o	tr.	+	N 62 ...	1000		c	
N 27 ...	1500	1000	c		N 63 ...	1000	1000	c	c
N 28 ...	1500	1000	c	+ + +	N 64 ...	o	o	o	
N 29 ...	o	o	o	o	N 65 ...	100	100	tr.	
N 30 ...	100	o	o	+	N 66 ...	500	500	o	tr.
N 31 ...	1000	1000	c		N 67 ...	100	100	o	tr.
N 32 ...	1500	1500	c	c	N 68 ...	o	500	o	tr.
N 33 ...	1500	1500	c	c	N 69 ...	500	500	c	c
N 34 ...	1000	1000	c	c	N 70 ...	1500	1000	c	c
N 35 ...	1000	1000	c	c	N 71 ...	1000		c	
N 36 ...	500	1000	c	c					

It will be seen that, as with the spinal strains, the two sera have much the same agglutinating properties, the differences observed being of a minor quantitative character. Taken together they agglutinate to the full titre 30 of the 71 strains, while 9 others are agglutinated to 1-1000 and 5 to 1-500 with

one or other serum. This leaves 27 strains which on agglutination results are excluded from the group represented by C.S. 14 and C.S. 16, and already defined as Group II.

The results of absorption are closely comparable: 37 strains remove completely the agglutinin for the homologous strain from one or both the sera, while 3 others remove it almost completely, the effect being noted as + + + which means, as before, that agglutination of the homologous strain by the serum after absorption was complete at 1-100 but incomplete at 1-500. These 40 strains include the 30 reaching the full agglutination titre, the 9 reaching 1-1,000 and 1 of the 5 reaching 1-500.

With the remaining 31 strains absorption was either entirely negative (7 strains) or reduced the titre of the serum only to a slight degree.

The conspicuous feature of the table is thus the large number of strains, 56 per cent., which can be identified with one or both of the two strains of spinal origin, this identification depending on the combining properties of the strains in question with the anti-bodies produced by the known pathogenic meningococci. This predominance of Group II strains applies both to contacts and non-contacts, and in this connection it is of great interest to remember that in the collection of 60 known pathogenic strains only 21, 35 p.c., were identified with this group, while 33, 56 p.c., were either identified with, or shown to be nearly related to Group I.

There remain among the 71 naso-pharyngeal strains 31 which have still to be identified.

Among these, 10 have been specifically identified with spinal strains belonging to Group I and its immediate allies, while 6 strains have given evidence of relationship but not identity. Table XIV summarises the reasons for the specific identification or relationship of these Group I naso-pharyngeal strains under the headings of (1) agglutination with sera prepared with spinal strains of the group, (2) absorption of agglutinin from these sera, (3) agglutinogenic action in the case of 8 strains showing that the sera produced by them agglutinate certain spinal strains, and (4) absorption of agglutinin from these sera by these spinal strains. Information on the last two points has not been collected in the case of all strains, since the labour involved in preparing and testing sera with all would probably not have given results of proportionate value.

The sub-groups referred to in the column headed *"Absorption of Group I Agglutinin and consequent sub-grouping"* are those found among spinal strains and recorded in Table III.

TABLE XIV.

Serological relationship and classification of naso-pharyngeal strains allied to Group I.

Strain.	Agglutination with Group I Sera.	Absorption of Group I Agglutinin and consequent sub-grouping.	Agglutinogenic Properties, *i.e.*, Reactions of Serum prepared with Strain.	
			Agglutination of Spinal Strains.	Absorption with same Spinal Strains.
N 1	Serum P 1, 500 „ C.S. 8, 1,000	Serum P 1, + „ C.S. 8, c Sub-group (1).	[Full Titre, 1,500] Main Group I, 100 C.S. 8 Group, 1,000 Main Group II, o	 + c o
N 2	Serum P 1, 100 „ C.S. 8, tr. „ A 2, 800	Serum P 1, o „ C.S. 8, o „ A 2, c Sub-group (4).	[Full Titre, 1,000.] Main Group I, tr. C.S. 8 Group, tr. A 2, 600 Group II, o	 o o c o
N 3	Serum P 1, tr. „ C.S. 8, 0 „ A 2, 500	Serum P 1, o „ C.S. 8, o „ A 2, + + Related to sub-group (4)	*Not tested.*	*Not tested.*
N 4	Serum P 1, 500 Sera C.S. 8 and A 2, 100 „ A 13 and A 10 1,000	Serum P 1, o Sera C.S. and A 2 o „ A 13 and A 10 c Sub-group (3).	„	„
N 5	Serum P 1, 100 „ A 10, 500	Serum P 1, tr. „ A 10, + + + Sub-group (3).	„	„
N 7.	Serum P 1, 500 „ A 2, 500	Serum P 1, o „ A 2, + Related to sub-group (4)	[Full Titre, 800.] Main Group I, 300 A 2, 800 Group II, 300	 tr. [A 12 = + + +] + + o
N 8	Serum P 1, 500 „ A 2, 500	Serum P 1, o „ A 2, + Related to sub-group (4)	*Not tested.*	*Not tested.*
N 10	Serum P 1, 500 „ C.S. 8, 0 „ A 2, 500	Serum P 1, + + „ C.S. 8, o „ A 2, + + + Sub-group (4).	[Full Titre, 1,000.] Main Group 1, 500 Group C.S. 8, tr. A 2, 1,000	 + o + + +
N 11	Serum P 1, 100 „ C.S. 8, 100 „ A 2, 500	Serum P 1, o „ C.S. 8, o „ A 2, + Related to sub-group (4)	*Not tested.*	*Not tested.*
N 13	Serum P 1, tr. „ C.S. 8, 500 „ A 10, 500	Serum P 1, o „ C.S. 8, + „ A 10, + + + Sub-group (3).	[Full Titre, 1,500.] Main Group 1, 500 Group C.S. 8, 100 „ A 10, 1,000 „ II., 100	 o o + + + o
N 19	Serum P 1, 1,500 „ C.S. 8, 100	Serum P 1, c „ C.S. 8, tr. Main Group I	[Full Titre, 1,500.] Main Group I, 1,000 C.S. 8, 100	 c [A 17 = + +] o
N 29	Serum P 1, 500 „ C.S. 8, 500 „ A 13, 1,500	Serum P 1, tr. „ C.S. 8, o „ A 13, c Sub-group (2).	[Full Titre, 1,000.] Main Group I, 100 Group C.S. 8, o „ A 13, A 10, 1,000	 + o c [A 10 = + + +]
N 48	Serum P 1, 100	Serum P 1, + ? Sub-group (5).	[Full Titre, 1,000.] Main Group I, 100 Group A 13, 500 Unidentified B 3, B 10, A 1, A 16, } 1,000 Group II, 100	 + + + + + + o
N 58	Serum P 1, 100 „ A 2, 500	Serum P 1, o „ A 2, + + + Sub-group (4).	*Not tested.*	*Not tested.*
N 67	Serum P 1, 100 „ A 2, 500	Serum P 1, o „ A 2, + + + Sub-group (4).	„	„

On examining this table it will be seen that only one strain, N 19, has been found identical with the main Group I, one strain, N 1, with the sub-group (1) represented by C.S. 8, one strain, N 29, with the sub-group (2), of which A 13 is the type, three strains, N 4, N 5, and N 13, with the closely-related sub-group (3), of which A 10 is the type spinal strain, while four, N 2, N 10, N 58, and N 67, have been identified with the sub-group (4), represented by strain A 2, which, though allied to the main Group I., is highly specialised, and has no near relative among my other spinal strains. One strain, N 48, is of much interest as being closely related to, if not identical with, four of the spinal strains which could not be identified by the use of any of the spinal sera, though two of them possessed definitely stronger affinities for Group I, and were hence put in sub-group (5), while two were indifferent to both the main group sera, and were put in sub-group (7), the "scrap-heap." In addition four strains, N 3, N 7, N 8, and N 11 have been shown to possess relationship with the spinal strain A 2, but on evidence insufficient for the presumption of specific identity. One of these, N 7, is similarly related to at least one of the main Group I strains, A 12, the relationship in common being apparently some quality of a minor nature in the case of A 12, since it is insufficient to differentiate A 12 from others of the main group.

In the case of one strain, N 18, not included in the table, the evidence of relationship to Group I is confined to the single fact that it agglutinates much better with Group I than with Group II sera. Absorption tests, however, fail to identify it with any spinal strain, and its agglutinogenic action has not been ascertained owing to its extreme toxicity for rabbits.

There remain fifteen naso-pharyngeal strains which resemble the spinal strains from cases in children, B 1, B 5, B 3, and B 10, in their poor reaction with all the spinal sera tested.

Eleven of these, N 12, N 14, N 16, N 20, N 26, N 37, N 49, N 64, N 65, N 66, and N 68, agglutinate completely up to 1-500 with serum P 2, but absorb insignificant amounts of P 2 agglutinin (*vide* Table XIII). They show at most traces of agglutination with the various Group I sera, and, like the spinal strains referred to above, cannot be definitely brought into relationship with each other or with any of the other spinal strains. Their nearest allies, to judge by agglutination, are the Group II strains; perhaps sera prepared with the more divergent members of this group might identify these unclassified spinal and naso-pharyngeal strains, but in default of such sera they must all be placed as *incertae sedis*.

Of the remaining four strains, N 53, N 30, N 23 and N 24, *strain N* 53, the strain isolated from a soldier who had been pronounced to be a "chronic carrier," similarly unidentified by absorption, agglutinates completely at 1-100 but not higher with sera P 2 and A 2, fails to absorb from both these sera, and neither agglutinates nor absorbs agglutinin with the others; its position in the meningococcus category is thus still more indefinite. *Strain N* 30, however, though agglutinating feebly or not at all with the spinal sera, is strongly agglu-

tinated by the serum prepared with N 1, and absorbs almost all its agglutinin; but N 1 has been shown to conform to the tests of specific identity with the spinal strain C.S. 8, so that strain N 30, though itself divergent from this spinal strain, evidently possesses a protein-molecule resembling to a large extent that of the strain N 1; and this molecule, as has been seen, can carry combining properties of high valency for the C.S. 8 group serum: N 30, therefore, is linked up to the sub-group (1) through the intermediary strain N 1. Similarly, *strains N 23 and N 24*, though agglutinating relatively feebly with spinal sera, agglutinate up to 1-800 with the serum prepared with strain N 48, and absorb most of its agglutinin. This N 48 serum, as has been noted, agglutinates to full titre, and is absorbed by, certain strains of spinal origin which themselves were unidentified by the use of spinal sera, and were hence put in the "scrap-heaps", sub-group (5) or sub-group (7).

Had I prepared sera with such spinal strains they might have resembled serum A 2 in the peculiar restriction of their specific properties, and, like it, might have picked out and identified with themselves naso-pharyngeal strains such as N 23 and N 24, which, in absence of the appropriate spinal serum, can be brought into relationship with strains of known pathogenicity only in virtue of their relationship to another naso-pharyngeal strain N 48.

Relative Proportions of the Different Groups.

(*a*) *In cerebro-spinal and naso-pharyngeal strains.*

In my collection of the former, 55 p.c. were allotted to Group I and of these almost three-fourths were of one type as determined by absorption tests, and this was therefore called the main Group I. Among the naso-pharyngeal strains only 22 p.c. were related to Group I, and of these only 6 per cent. belonged to the main group of this, while 25 p.c. belonged to the rare sub-group (4), of which A 2 is the type: the other sub-groups (2) (3) and (5) having, as among the spinal strains, one or two members each.

On the other hand (as I have already mentioned), the main Group II included 56 p.c. of the naso-pharyngeal strains and only 35 p.c. of those of spinal origin, while 8·5 p.c. of the spinal strains and 21 p.c. of the naso-pharyngeal remain ungrouped.

It has been suggested in discussing spinal strains (p. 143) that the difference in relative proportions of the different groups may indicate that the serological qualities of the different members may not depend on fixed characters, but are subject to modification as the result of their environment. It might seem from the above statistics that the Group II condition of the meningococcus was more characteristic of it while sojourning in the naso-pharynx, and that in that region modification in the direction of Group I. rarely reached the full degree as represented by the main group of the Group I spinal strains, but that it halted at the stage represented by the sub-groups of Group I, which are less distantly related to Group II. It is

equally possible that residence in the naso-pharynx tends to modify Group I strains in the direction of Group II.

But the most important indication furnished by a comparison between the groups found in the two classes is that each serological type found among the strains of pathogenic origin is represented among those from the normal naso-pharynx, and it seems probable that, if a sufficient number of pathogenic strains were examined for comparison, all the naso-pharyngeal strains would find an identical type among these.

In 58 of my 71 naso-pharyngeal strains sufficient serological similarity exists to permit of identification with strains of cerebro-spinal origin by complete or well-marked absorption of the agglutinin fitting these, while only 13 remain in which relationship is suggested by agglutination but has not been confirmed by absorption. The complete identification of these 13 strains might involve prolonged search for spinal strains similarly aberrant and the production of many sera with these before the exact type of aberration in each naso-pharyngeal strain met its prototype among those of spinal origin. It is evident, I think, that, given the necessary time and material, for any type of coccus in the naso-pharynx possessing the morphological and cultural characters of the meningococcus a counterpart may be found, possessing its more or less peculiar serological reactions, among cultures from the meninges.

(*b*) *As regards age of patient and severity of disease produced.*

In 36 of my 60 spinal strains I know the age of the patient from whom the strain was cultivated. Of these, 25 were of 13 years or under, while 12 were over 13. Of the 25 strains from children, 9 were classed as Group I and 16 as Group II, while of the 12 adult strains 9 were of Group I and 3 of Group II. Though these are small figures from which to draw deductions, there is some indication that Group II affects children more than adults.

Twenty cases recovered and 8 died, the fate of the others being unknown to me. Of the cases which recovered 14 belonged to Group I and 6 to Group II, while 2 Group I cases died and 6 Group II. One cannot argue from this that Group II strains produce the severer infections; my results are probably due to their greater incidence on infants. This greater incidence of Group II on infants may indicate that the infection of children is frequently acquired from normal adults who, as has been shown, are apt to harbour Group II strains more than Group I.

Scientific and Practical Value of Serological Tests.

(*a*) *Absorption.*

I have now described more or less fully the serological reactions of 131 strains, of which 60 were of known pathogenicity, while 71 had shown no evidence of capacity for producing disease in the particular host.

In the first place, the value of these reactions in differentiating groups within the broad meningococcus category requires

consideration. It has been seen that on the strength of agglutination two main groups are well defined: members of each group agglutinate strongly with the sera prepared by inoculation of members of the same group but feebly or not at all with sera prepared from members of the other group.

But on subjecting these main groups to more elaborate serological tests differences appear among strains which on simple agglutination would at first sight be grouped together. These differences already begin to reveal themselves when careful estimation is made of relative agglutinability with different sera and are still more marked when the power of absorbing agglutinin is taken into account. In many cases, indeed, these differences in absorptive character are absolute, *i.e.*, there is either complete absorption, indicating perfect adaptation of the bacterial receptors towards the agglutinin, or complete absence of absorption, showing that the special combining parts of the protein molecule for the particular agglutinin are entirely lacking.

By some authorities,* as I mentioned before, such differentiation is regarded as sufficient for the erection of species among strains belonging to the Food-Poisoning Group which are otherwise indistinguishable from each other. There some support is given to such an attitude by the differences in pathogenic action said to be shown by the proposed species, the one being associated with continued fever and the other with acute enteritis. But in the case of the meningococcus there is little evidence of difference in the disease produced by the different groups, and the question arises, What is the significance of the limitation to certain strains of the power of absorbing agglutinins? Is one justified in saying that the capacity for absorbing each other's agglutinin, which is found to be the common property of certain strains but absent from others, is sufficient to define the former as fixed types or species?

The final answer to such questions cannot, of course, be given until bacteriologists agree as to the criteria necessary for the erection of species among bacteria. But if it is agreed that this character, the absorption of each other's agglutinin, defines strains as belonging to a fixed type or species, then the number of such fixed types or species of meningococcus must be taken as very large, since, even in the small collection of strains which I have been able to study, there appear on this basis at least eight of them. It follows that in the placing of an unknown strain in relation to its proper type on this principle of classification at least eight monovalent sera must be applied. Yet even eight sera would fail to classify by absorption all the meningococci found producing disease.

Further, although in many cases the special power of absorbing a certain agglutinin appears sharply and definitely peculiar to certain strains, in others it appears to depend on quantitative rather than on qualitative differences, and the presence or absence of absorptive capacity is much less sharply defined. For

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* Bainbridge and O'Brien, Journal of Hygiene, Vol. xi, p. 68, 1911.

example, in the case of strains C.S. 4, A 13, A 23, and A 10 absorption tests might lead to each being given the status of a separate type or to all being put together according as large or small quantities of culture were employed in the reaction.

Added to this difficulty, there is a serious element of confusion arising from the fact, already noted, that the same strain may vary in absorptive capacity on different occasions. Even with the main groups doubt may arise as to the type to which a particular strain should be assigned: for example, the Group II strain C.S. 16 has been seen to absorb agglutinin completely, not only from all the typical Group II sera, but also from the Group I serum A 10.

The conclusion, I think, should be that peculiarities in the absorption of agglutinin are not of sufficient permanence and are not sufficiently sharply defined in all cases to permit of their employment in the creation of hard-and-fast types or species. If they are investigated and determined with all the accuracy possible, it is evident from the number of distinct sub-groups which I have demonstrated in my small collection of strains that a useless multiplicity of types would be created; if rougher tests are depended on, the different types shade into each other and no boundary line can be drawn.

But in the meantime the chief interest of these elaborate serological reactions is the practical one. Can one by their use distinguish a meningococcus of pathogenic origin from other cocci morphologically and culturally identical?

There can be no doubt that the positive demonstration of mutual absorptive capacity for each other's sera proves sufficiently the serological identity of two strains; and such proof involves the admission that where one of the two is known to have caused disease, the other, whatever its origin, must be capable, under the proper conditions, of doing the same. Even when absorptive capacity has been demonstrated only for one strain with the serum of the other, *i.e.*, where a naso-pharyngeal strain absorbs the agglutinin from a spinal serum, it is probable that the same proof and admission may be allowed.

But it does not at all follow that the failure to demonstrate such identity by absorption tests excludes the coccus of unknown pathogenicity from the category of possible pathogenic strains. For it is evident, even in my small collection, that differences sufficient to prevent identification with each other are already numerous among the known pathogenic meningococci, and the probability of success in such identification is in direct proportion to the number of different sera used.

To take a concrete example, suppose the known pathogenic strains A 7 and C.S. 20 had been submitted for diagnosis as being of doubtful pathogenicity, and suppose, as might easily have happened since the group to which it belongs forms only 5 p.c. of my total, that the serum C.S. 8 had not been prepared or used, then these two strains would have been tested in vain against at least four different sera; if the positive result of an absorption test had been regarded as essential, they would have

remained as doubtful meningococci or might even have been excluded altogether.

Hence the practical attitude towards the absorption test for the identification of unknown strains with pathogenic meningococci should be that a positive outcome is decisive, that a negative result means nothing, and that even when this latter repeats itself with several different sera it does not exclude the strain from possessing pathogenicity.

(b) *Agglutination.*

Although the absorption test is too precise in its action and might exclude not only strains from the naso-pharynx of indeterminate serological character, but also known pathogenic strains, it remains for discussion whether simple agglutination might not furnish a criterion distinguishing naso-pharyngeal strains of common occurrence among non-contacts from those of spinal origin. Simple agglutination is less precise in its action and not confined as in the case of the absorption test to strains exactly identical with the strain producing the serum. Some authorities maintain that by simple agglutination a rough line could be drawn including the great majority of the pathogenic strains and excluding a large proportion of the strains commonly occurring in the normal naso-pharynx, and that it constitutes, therefore, a most useful criterion for practical use in determining the danger to be attached to meningococcus carriers.

This is the view taken by Colonel Mervyn Gordon in his recommendations for the control of cerebro-spinal fever in the Army,* his reasoning, I think, being that naso-pharyngeal strains which fail to reach the full agglutinin titre with any of his four types of serum prepared from pathogenic strains are to be distinguished from strains of epidemiological significance.

My results indicate that there are many more than four agglutination types among pathogenic meningococci, since I have found at least eight and even then have left some unidentified.

It might theoretically be possible, however, to collect and classify a representative series of pathogenic strains and to prepare with them a manageable set of sera, to one of which, at least, any meningococcus of cerebro-spinal origin would respond in positive fashion; and it would make the task easier if abnormal strains occurring in sporadic cases and among infants could be ignored. In such circumstances a coccus from the naso-pharynx which failed to agglutinate satisfactorily might be put down either as not pathogenic or as belonging to a type producing disease so rarely that it escaped collection, and hence must be of no epidemiological importance.

But against this is the difficulty that variations in agglutinability, as has been shown, are very great and might easily lead to the exclusion of pathogenic strains if one test only were applied; indeed, with the naso-pharyngeal strains in particular,

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* Medical Research Committee, Special Report Series, No. 3, p. 7.

agglutinability is often much less pronounced in the first subculture than in succeeding ones.

Still more important as affecting the use of naso-pharyngeal swabbing in the control of cerebro-spinal fever is the prevalence in the normal naso-pharynx of meningococci of typical serological character. This is so great that the most elaborate investigation of naso-pharyngeal strains could only exclude quite a minor proportion of the total found; the great majority are identical with types of pathogenic strains of frequent occurrence in the epidemic disease and exclusion of the few which remain unidentified with my pathogenic strains would not modify the epidemiological problem represented by the large percentage of positive findings which I have demonstrated among normal persons.

Prevalence of Naso-pharyngeal Meningococci in the Various Groups of Persons Examined.

In my first report on this subject I showed that among the outpatients attending Lambeth Infirmary in June and July, 1915, 22 p.c., 30 out of 138 examined, although they had had no relation to cerebro-spinal fever, harboured in their naso-pharynx micro-organisms indistinguishable from the meningococcus in morphology and culture, while in 13·7 p.c., 19 out of the total, the serological reactions of the strains isolated confirmed their meningococcal nature. During May, 1915, 56 school children attending a rural school in Kent were similarly examined with negative results, one strain only being found which on cultural and morphological characters resembled the meningococcus; it failed, however, to respond to the serological tests applied.

In the present report additional material in the form of naso-pharyngeal strains has been collected, and these as well as the strains previously described have been submitted to more elaborate serological examination.

On 20th January, 1916, 20 children, infants under seven years attending an urban school, were examined. Again only one suspicious strain was found; it failed to agglutinate with any serum, and died out before further tests could be performed.

During the four months February to May, 1916, I had, in the course of my public health duties in a small area in North-East Kent, an opportunity of investigating the carrier percentage among soldiers and of comparing the results found where cerebro-spinal fever had occurred with those among men who had had no connection with the disease. Omitting the school children, I have thus a set of strains from civilians (Lambeth) dating from 1915 and seven sets of soldiers, a total of 142, dating from 1916, each set forming a sample of a different body of men but in each case of men living in the conditions of close association found in camp or barracks.

The general result has been to confirm the conclusion arrived at in my first report that meningococci are to be found in a considerable percentage of persons in whom no relation to cases of cerebro-spinal fever is discoverable. In the case of the

Lambeth population the percentage, as revised in the light of more elaborate study of the strains, and on the basis of full serological identification, is 11·6 p.c., while among the soldiers the percentage on the same basis varied from 10·5 p.c. to 57·6 p.c. among those in whom relation to the disease was either absent or remote, and from 25·9 p.c. to 37·5 p.c. among those in direct contact with cases.

In the following table (Table XV.) the various points of importance in connection with each set are given for comparison, together with the percentages of persons in whom meningococci were cultivated from the naso-pharynx.

TABLE XV.

Meningococcus carriers in the different population groups.

No. of group.	Description of group and relation to whole population.	Date examined.	Relation to cerebro-spinal fever before examination.	No. examined.	Percentage with meningococci identified completely by absorption tests.	Percentage including meningococci which show relationship by absorption tests but not identity.	Percentage including meningococci agglutinating with anti-meningococcus sera but not absorbing.	Relation to cerebro-spinal fever after examination.
					per cent.	per cent.	per cent.	
1	Lambeth Out-Patients (revised statistics).	June 1st—July 15th, 1915.	None demonstrable.	138	11·6	16	22	None known.
2	Soldiers, Garrison A of 500 men.	Feb. 17th, 1916.	None	20	20	25	35	None.
3	Soldiers in huts, Battalion at M. of 2000.	March 2nd, 1916.	None	19	10·5	15·5	21	2 Cases in Battalion 3 months later.
4	R.A.M.C. staff of Battalion at T.	March 23rd, 1916.	2 cases in connection with battalion 1 week before, not direct.	5	40	60	60	None.
5	Soldiers of Battalion at T. of 1,500 men.	March 28th, 1916.	The above 2 cases, but not direct.	19	57·6	57·6	63·2	None.
6	Six soldiers, 2 civilians in billets in Town S.	March 20th(4) April 5th(4)	Direct contacts of cases.	8	37·5	37·5	37·5	None.
7	Soldiers in huts of Battalion at M. as in (3)	May 11th, 1916.	None	18	33·3	33·3	38·9	2 Cases, not in same huts, but in battalion on May 24th
8	Soldiers in huts of Battalion at M. as in (3) and (7).	May 26th, 1916.	2 cases in same huts, direct contacts.	54	25·9	25·9	33·3	None.

TOTALS.

Civil	Group 1	1915	Non-contact	138	11·6	16	22
Military.	Groups 2, 3, 7	1916	Non-contact	57	21	24·5	31·5
Military.	Groups 4, 5	1916	Doubtful indirect contacts	24	54	58	62·5
Military.	Groups 6, 8	1916	Direct contacts.	62	27	27	34

In analysing this table it will be best to discuss first each set *seriatim* and to reserve the general considerations to the end.

In the first set, the Lambeth out-patients, out of 138 individuals, 30, or 22 p.c., furnished strains culturally identical with the meningococcus, 19 of which, making 13·7 p.c. of the total, were also similar serologically.

Of these 30 strains 16 have been submitted to more elaborate serological tests, the rest having accidentally perished in the interval.

The following are the results of this reinvestigation:—

In First Report.	On more elaborate tests.	
	Complete identity.	Incomplete proof of identity.
Identified by agglutination ... 11 strains	8 strains	3 strains
Identified by culture ... ... 5 strains	1 strain	4 strains
16	9	7

As these 16 strains have not been selected in any way, the remainder having been eliminated by accident during sub-culture, they may be considered as fairly representing the original 30; calculated on this proportion the percentages of persons harbouring meningococci of the same serological types as those found in cerebro-spinal fever is reduced to 11·6 p.c., as shown above. None of the 138 persons examined had had any connection with cases of meningitis as far as careful inquiry could determine, and no case of cerebro-spinal fever has occurred to my knowledge among them since.

The next group, No. 2, dates from 17th February, 1916, about nine months later, and consists of 20 soldiers collected in four batches of five from different rooms in garrison barracks. The total strength of the garrison at the time was about 500 men; the sample taken, though small, was, I think, fairly representative. There had been no case of cerebro-spinal fever in the garrison for at least two years.

Four of these men, one out of each batch of five, gave cultures of typical meningococci, serologically identical with types apparently common in the epidemic disease; the percentage is thus 20 p.c. If the strain is included which showed serological relationship but not identity, the percentage rises to 25 p.c.,

while if all cases are included in which strains culturally identical were found the percentage becomes 35 p.c.

The next group in chronological order, Group 3, consisted of 19 men (20 were swabbed, but from one man both plates were overgrown with contaminating organisms, so that he is excluded from the set). These were swabbed on 2nd March, 1916, and came from soldiers of four different training companies living in huts in and near a coast village in Kent. Some 2,000 soldiers in all were encamped there, and no case of cerebro-spinal fever had occurred among them since the construction of the camp. Two of these men were found to be carrying typical meningococci; from two others other two strains were cultivated, one of which showed definite relationship to pathogenic strains by absorption, while the other could not be identified thus although it agglutinated to some extent with specific sera. The percentage of positive carriers on the first basis is thus 10·5 p.c., on the second 15·5 p.c., and on the third 21 p.c.

The next group, Group 4, was examined on 23rd March, and consisted of five men on duty in the medical inspection room attached to a training battalion of about 1,500 men in camp in a rural parish in Kent, but about a mile from a small town.

Two cases of cerebro-spinal fever had occurred in connection with this battalion one week before; one case was a soldier belonging to it who developed the disease and died while away on leave; the other was an infant living in a small house where two of the soldiers were billeted. Indirect connection probably occurred between the contacts of these cases and the medical staff, though none of an intimate character, as far as is known.

Two of the five were found to be carrying typical meningococci, while a third yielded a strain showing definite relationship by absorption tests; the percentage of carriers was thus 40 p.c. on the first basis and 60 p.c. on the second.

Group 5 consists of 19 men of the battalion just described. They came up for vaccination, being recent recruits, on 28th March, 1916, and the opportunity was taken to examine their naso-pharynx. They had been living for a fortnight under canvas, but not all in the same tent. Their relation to cases of cerebro-spinal fever is similar to that described in connection with the previous group but more remote. Eleven of the 19 men were found to be carrying typical meningococci, and a twelfth yielded a strain related by agglutination reactions but failing to absorb. On the first basis 57 p.c. were carriers, on the second 63 p.c. A month later I examined the carriers again and found in every case meningococci of the same typical character.

Groups 6, 7, and 8 were all connected with cases of cerebro-spinal fever either immediately before or after swabbing, as contrasted with those hitherto described in whom connection with this disase was either absent or remote. In Groups 6 and 8 swabbing was done after direct connection with a case had been established; in Group 7 two cases occurred a fortnight after though not in direct connection.

Group 6 consists of contacts in billets of two cases in a small town in Kent, both soldiers, but of different battalions, the contacts consisting of three soldiers and one civilian in each case. The first case occurred on 20th March, the second on 5th April, the contacts of each being examined the following day. Two of the contacts with one case and one with the other were found to be carrying typical meningococci indistinguishable by absorption tests from pathogenic strains and from the 11 strains found in the previous group. The percentage on the total of eight contacts is thus 37·5 p.c. No restrictive measures were adopted in the case of one, a civilian; the soldiers were isolated by the military authorities concerned. No other cases appeared in the town during 1916.

Group 7 is drawn from the same battalion as Group 3, but consists of 18 different men living under the same conditions in the same place and collected from eight different companies. They were swabbed on 11th May, ten weeks after the first batch described under Group 3. No cerebro-spinal fever had occurred in the interval. Six of the 18, or 33 p.c., yielded typical meningococci, and one other gave an atypical strain which agglutinated up to 1-500, but failed to absorb agglutinin. If this one is included the percentage of carriers is 39 p.c.

The contacts living in the same two huts as two cases of the disease constitute Group 8, and were examined two days after the appearance of the disease. None of these men had come into the previous selections made for Groups 3 and 7. Out of the 54 contacts 14 yielded typical meningococci, a percentage of 26 p.c., while four others gave strains which agglutinated somewhat feebly with specific sera and failed to absorb agglutinin. If these four are included, the total carriers amount to 33·3 p.c.

Summary and Conclusions.

(1) Meningococci from 60 cases of cerebro-spinal fever have been submitted to serological tests and compared with meningococcus-like micro-organisms from the naso-pharynx of 71 normal persons. In these serological tests 19 monovalent anti-meningococcus sera were employed, of which 11 were prepared with meningococci of known pathogenic origin and 8 with strains isolated from the naso-pharynx. The tests comprised careful estimation of the agglutinability of these 131 strains with the 19 different sera and also of the extent to which these strains absorbed and removed the agglutinin from one or more sera.

(2) The simple agglutination reactions effected a rough subdivision of these 131 strains into two groups, Group I and Group II, and indicated that in Group I there was a main group comprising the majority and at least five smaller groups each comprising a few strains only, while in Group II again a main group appeared comprising the majority and at least two smaller groups containing a few strains only.

(3) Tests for absorption of agglutinin confirmed this rough sub-division into two groups and distinguished with much greater precision the different main groups and smaller groups. In general, each of these groups was found to differ in that they

did not absorb the agglutinin for members of the others, and members of each produced sera from which members of the others similarly failed to absorb agglutinin.

(4) Two of the smaller groups, however, represent two "scrap-heaps" of strains unidentified by absorption reactions but suggesting by their agglutination reactions that they belonged to Groups I and II respectively. In the former there were placed 3 strains of cerebro-spinal and 1 strain of naso-pharyngeal origin, and in the latter 4 strains of the former origin and 13 strains of the latter.

(5) The other main groups and smaller groups contained representatives of both cerebro-spinal and non-contact naso-pharyngeal strains, though not in equal numbers: in the main group of Group I there were placed 24 spinal strains and only 1 non-contact naso-pharyngeal; in the main group of Group II there were placed 16 spinal strains and 40 naso-pharyngeal, of which 23 were from non-contacts and 13 from contacts.

(6) Variations in agglutinability and absorptive capacity were shown to be so great as to interfere seriously with the use of serological tests for identifying meningococci in practice.

(7) An additional difficulty affecting both the identification of meningococci and their classification into types or groups and sub-groups is that, even with seven sera, each corresponding to a different group, strains were found, both spinal and naso-pharyngeal, which failed to react typically with any and therefore could neither be ascribed to a particular type or group nor be identified on serological grounds with the other pathogenic strains.

(8) Hence it was concluded (*a*) that it is impossible to regard these types or groups as representing distinct classes limited by hard and fast lines, and (*b*) that it is unsafe to exclude any strain from possible pathogenicity on the ground of its failure to agree serologically with any of such sets of sera as are likely to be available in practice, since even the large series I employed failed to include all pathogenic strains.

(9) The conclusion in my first report is therefore maintained that any strain possessing the admitted morphological and cultural characters of the meningococcus should be regarded as potentially pathogenic without considering its serological reactions.

(10) I have found, however, that the strains obtained from the majority of carriers show by absorption tests complete serological identity with known pathogenic strains. To this criterion 58 of my 71 naso-pharyngeal strains conform. These were distributed as follows: 16 out of 138 out-patients attending Lambeth Infirmary in June and July, 1915 (11·6 p.c.); 12 out of 57 non-contact soldiers in February, March and May, 1916 (21 p.c.); 13 out of 24 soldiers in March, 1916, who had had no direct connection with cerebro-spinal fever but in whose neighbourhood 2 cases had occurred (54 p.c.); 17 out of 62 soldiers who had been in direct contact with cases of the disease (27 p.c.).

(11) Inclusion of those persons who were found to be carrying strains not fully identified serologically did not raise the percentage of carriers to a significant extent.

V.—A Bacteriological Investigation of Organisms resembling the Meningococcus found by Examination of the Naso-pharynx of Persons who had not been in Contact with Patients suffering from Cerebro-Spinal Fever: by Constant Ponder, M.D., Captain R.A.M.C. (T.).

INTRODUCTION.

The presence of the meningococcus, or an organism indistinguishable from it by any known tests, in the naso-pharynx of persons who have not suffered from cerebro-spinal fever, nor been in contact with other persons suffering from this disease, has been studied during the year 1915 by Drs. Eastwood, Griffith and Scott.* Their results showed that in the London District an unexpectedly large proportion of persons examined were carriers of this organism. In view of these results the Medical Officer of the Local Government Board considered it desirable that a further investigation should be made in a different district, where the incidence of cerebro-spinal fever had been low, and where, consequently, chances of spread of the meningococcus by direct contact with the disease would be small. The Eastern Counties seemed to meet these requirements, and accordingly, after the War Office had loaned my services to the Local Government Board for this purpose, I was instructed by the Board's Medical Officer to make investigation on the subject in question amongst the inhabitants of Cambridge, Norwich, and the surrounding areas.

* Local Government Board: Reports on Cerebro-Spinal Fever (New Series 110), 1916.

I am greatly indebted to Drs. Eastwood, Griffith and Scott for their valuable help during the investigation; by utilising their experiences fully in regard to media and methods a good deal of preliminary work was avoided.

The earlier part of my work, from June to October, was done in the Pathological Laboratories of the Medical Schools at Cambridge, for the use of which I wish to thank Professor Woodhead.

I am also much indebted for help, at Cambridge, to Dr. Laird, the Medical Officer of Health of the Borough, Captain J. C. Graham, Dr. Varrier Jones and Dr. Carter (of Soham). At Norwich, Dr. Cooper Pattin (the Medical Officer of Health), Dr. Claridge, and Dr. Long gave me every assistance. Dr. Claridge, Pathologist to the Norfolk and Norwich Hospital, very kindly placed his laboratory at my disposal during my visit to the city.

The latter part of the investigation, from October, 1916, to February, 1917, was devoted to the serological examination of the strains found and was done in the Board's Laboratories.

Incidence of Cerebro-spinal Meningitis Amongst the Population in the Areas Investigated.

The following summary, which is prepared from information kindly supplied by the Medical Officers of Health of Cambridge and Norwich, gives details of all cases notified during 1916.

Cases of Cerebro-spinal Fever notified in Cambridge and Norwich between Jan. 1st and Dec. 31st, 1916.

	Patient.	Date.	Address.	Termination.	Notes.
Cambridge (Pop. 40,027)	Girl (age 6).	Mar. 27th.	Outskirts of town.	Recovered.	Only father and mother came in contact. No examination of throats was made.
	Girl (age 13).	Mar. 20th.	Outskirts of town.	Died.	First notified as enteric fever and removed to general hospital. No examination made.
Norwich (Pop. 121,478)	Woman.	Feb. 3rd.	Town.	Recovered.	The naso-pharynx of ten contacts examined and one found positive.
	Woman.	Feb. 15th.	Town.	Died.	Two contacts examined, none found positive.
	Soldier.	Feb. 28th.	Town.	Recovered.	Eight contacts examined, five found positive.
	Man.	Mar. 11th.	Town.	Recovered.	Ten contacts examined, none found positive.
	Girl.	Apl. 18th.	Town.	Died.	Four contacts examined, none found positive.
	Man.	June 8th.	Town.	Recovered.	Eight contacts examined, none found positive.
	Soldier.	Nov. 7th.	Town.	Died.	Contacts swabbed, negative.

No cases were notified at either place whilst my work there was in progress, and only one subsequently.

Considering the large population of these places and the small number of cases of the disease which occurred before the investigation had begun, it will be agreed that the number of persons who can have come in *direct* contact with patients must have been very small. How far *indirect* contact may have occurred it is impossible to say.

Attempts were made to include amongst the persons chosen for swabbing individuals of different classes, living under different circumstances and in different states of health.

The swabbings were carried out in three batches:—

(1) Two hundred swabs were taken in Cambridge during June and July, 1916, mostly from the naso-pharynx of out-patients at Addenbrooke's Hospital and their friends. Nearly all these patients were attending the eye department for slight defects and may, therefore, for the purposes of the investigation, be classed as normal people, since they were able to go about and in most cases do their work.

A few, however, taken at a Tuberculosis Clinic, came from patients suffering from phthisis in different stages, and the health of these patients must be classed as "impaired."

(2) A hundred swabs were taken at Norwich during August, 1916, from the naso-pharynx of medical and surgical out-patients and their friends attending the Norfolk and Norwich Hospital. Many of these patients had impaired health but all were well enough to be up and about.

(3) A hundred swabs were taken during October, 1916, amongst the employees at a factory in Cambridge where scientific instruments, etc., are manufactured. These employees were all in good health and, as they were all earning good wages, it may be assumed that their home circumstances were on the whole much more comfortable than those of the other two groups of persons swabbed.

Methods Adopted in the Investigation.

Method of Swabbing.

Success in recovering such a delicate organism as the meningococcus depends, I think, a good deal on the amount of care given to the taking of the swab. A simple form of swab is efficient if properly prepared. In this investigation I used a plain aluminium or tinned-wire rod; the end around which the wool was wrapped was bent round to an angle. Experience soon showed that this angle must be carefully adjusted; if it was too obtuse, the handle-end of the swab impinged on the lower teeth and the wool-wrapped end could not pass properly behind the soft palate, since its point struck the posterior wall of the pharynx. The angle should be slightly larger than a right angle. Wool was wrapped round the bent end so that no metal was exposed, and the part protruding beyond the end was cut off with scissors; thus the swab ended in a flat padded surface to which mucus easily adhered. I preferred such a swab to the guarded kind,

as one could guide the point with more accuracy; there was also a larger surface of wool brought in contact with mucous membrane.

The patient was placed in a good light and instructed to open the mouth as wide as possible. The tongue was depressed by a wooden spatula placed as far back as convenient. The swab then being held ready on the dry upper surface of the spatula, the patient was told to phonate the sound "ah," and, directly the soft palate rose as a result of this action, the bent end of the swab was passed up behind the soft palate. In carrying out this process the outer part of the wool is rubbed on the back wall and vault of the naso-pharynx, and, if carefully conducted, there is no possibility of contamination by saliva. That surface of the swab which had come in contact with the naso-pharynx was then rubbed over an ascitic-agar plate, taking care to transfer to the surface of the medium any beads or threads of mucus which had adhered to the wool.

Media and Cultivation of Swabs.

The plate to which the mucus was transferred contained ascitic-agar made from ordinary nutrient agar (reaction + 8) containing 2·5 per cent. agar. This, after being melted and cooled to 55° C., had received the addition of sterile ascitic fluid in the proportion of one part ascitic fluid to three parts nutrient agar.

The plates were taken to the laboratory without delay; but it was not found essential to keep them at blood temperature in a portable incubator, as some investigators have stated. The mucus was spread out on the plate by means of a bent glass rod, care being taken to tease it out as thoroughly as possible. The same glass rod was then wiped lightly over the surface of a second plate. The rod should only pass once over the surface, and a large plate is obviously better than a small one. This second plate contained Kutscher's medium prepared as follows:—To a broth made from fresh human placenta, 500 grms. to the litre, are added nutrose 2 per cent., glucose 1 per cent., peptone (Chapoteaut) 1·5 per cent., and agar 2·5 per cent.; the reaction is brought to + 8 (Eyre's scale) after steaming. Tubes containing a convenient amount are melted, cooled to 55° C., and sterile filtered ox serum is added in the proportion of one part to three; the medium is then ready to pour into the Petri dish.

The plates were examined after 24 hours and after 48 hours; if the second plate was spread as described above, a sufficient number of colonies, not overcrowded, was obtained almost invariably. The primary ascitic-agar plate was usually overcrowded with colonies, and was only examined when the Kutscher plate contained very few colonies.

Examination of Cultures and Preservation of Strains.

After some experience the colonies of meningococcus-like organisms on Kutscher's medium can be distinguished readily, even by unaided sight, in a mixed culture such as is obtained from a throat swab. Their colour is the bluish-grey of tobacco-smoke. After 24 hours growth they are about 2 mm. in diameter, translucent, and with a lens may appear faintly granular. They

are slightly raised, and the margins are regular. After 48 hours they are about 4 mm. in diameter, or even more where there is room for free growth; they preserve their original colour, translucency and faint granularity; they often show an annular appearance due to variations in thickness between the centre and circumference. In some strains the edges of the colonies may become slightly irregular and slight striation may be noticed. Colonies do not fuse readily one with another, and in the case of some strains a distinct facetting may be noticed where two or more colonies grow in contact. When emulsified, as a rule thev dissolve easily like paint; some strains may be slightly glutinous and some tend to adhere slightly to the medium. This latter characteristic appears to depend on certain qualities of the media. Some strains in subculture may assume a faintly yellow tint. These slight variations were also noticed in strains of meningococcus of cerebro-spinal origin.

When the meningococcus-like organisms were present in a throat culture, they often formed a large proportion of the colonies on the plate and sometimes they were present in almost pure culture. This appears to indicate that these organisms find a suitable *habitat* in the naso-pharyngeal mucus and are well able to hold their own in competition with the other flora.

Strains retained for further examination were sown on slopes of egg medium, on which they remain alive usually for several months. This medium is prepared as follows:—New-laid eggs with shells unbroken are placed one at a time in boiling water for 15 seconds, thus coagulating and sterilising the most external layer of albumen. The shells are then carefully broken on the edge of a sterile measuring cylinder, and the contents allowed to fall in without contamination. The amount is noted, and the contents of the cylinder are poured into a large sterile flask, which is shaken until all the yolks are broken. Sterile normal salt solution, in the proportion of one part to three parts of egg, is then added. The mixture is syphoned into test tubes and sterilised by inspissating in moist heat at 85° C., for two hours on each of two successive days. The plugs of the tubes are sealed with melted paraffin to prevent the medium drying.

Identification of the Meningococcus.

Satisfactory methods for identifying the meningococcus cannot yet be said to be established. There is no practical test of pathogenicity and one is compelled to fall back on cultural and serological tests, in regard to which a definite standard of identification has not been agreed upon. Where the organism is leading a pathogenic existence, knowledge of the locality whence the strain was isolated plays a strong part in influencing the decision. For example, meningococci and gonococci have many bacteriological characteristics in common, and even serologically can only be distinguished *in vitro* by tests which are not very definite; if, however, one is cultivated from cerebro-spinal fluid and the other from a urethral discharge, there is a valuable clue for differential diagnosis. But with an organism isolated from a throat, and perhaps living a saprophytic existence there, the

locality from which it is isolated gives no clue to its differentiation, since many varieties of gram-negative cocci occur in this region.

Cultural characters.

These have been described above in connection with the growth on Kutscher's medium. On subculture, certain strains were found to become yellow and glutinous; such strains often gave sugar reactions different from the meningococcus and invariably failed to agglutinate with the sera tested.

Microscopical characters.

Throat strains of meningococcus-like organisms seldom showed any difference in microscopical appearance from meningococci of cerebro-spinal origin. The presence of tetrads and larger groups of cocci varies, and seems to depend largely on conditions of growth.

Fermentation of sugars.

Strains were tested as regards their action on glucose, maltose and saccharose. The medium used was prepared according to Lingelsheim's formula. To 210 c.c. of ordinary 2·5 per cent. nutrient agar which has been melted and cooled to 55° C. are added 70 c.c. ascitic fluid, 20 c.c. of 10 per cent. solution of the required sugar, and sufficient Kubel and Tiemann's litmus to give a good blue colour, all these latter solutions being heated to a temperature of 55° C. The medium is then syphoned into test tubes and allowed to cool in a sloped position.

On such slopes the characteristic growth of the meningococcus is readily visible, and the production of slight acidity is easily detected. A recently isolated, vigorous strain of meningococcus will usually show definite acidity on glucose and maltose slopes in 24 hours, but no acidity can be obtained on saccharose slopes. Strains that have been stored and subcultured several times may fail to produce acidity with either glucose or maltose or perhaps with both.

The sugar reactions of the great majority of the meningococcus-like organisms isolated from the throat resembled the reactions of meningococci of cerebro-spinal origin. A few were found that fermented saccharose; these did not agglutinate with the sera tested. A certain number when freshly isolated failed to give acid with either glucose or maltose; these, for the most part, were difficult to emulsify, and suspensions rapidly showed spontaneous sedimentation. All but two failed to show satisfactory agglutination with the sera used. These organisms were probably related to the type which has been described under the name M. catarrhalis.

Serological tests; preparation of immune sera.

Young rabbits weighing 1,500 to 2,000 grms. were inoculated intravenously at intervals of 5-7 days with increasing doses of live 24 hour ascitic-agar slope cultures. A satisfactory series of doses was found to be a half slope for each of the first two inoculations, a whole slope for each of the next two inoculations,

and a slope and a half for each of the next two. In about six weeks to two months a serum which gave a titre for the homologous organism of at least 1:800 was usually obtained.

Nine monovalent sera were prepared, 7 from cerebro-spinal and 2 from naso-pharyngeal strains.

Preparation of suspensions of cocci.

The whole of the growth from a 24-hour old ascitic-agar slope was spread by means of a glass spreader over the surface of two or three Petri plates of ascitic-agar. After 24 hours' incubation the growth was scraped off and weighed and a suspension of the required strength was made up by adding sufficient phenol-saline solution (·5 per cent. phenol in normal saline).

For ordinary agglutination tests, the suspension was always used in a strength of 2 mg. to the c.c., making thus 1 mg. to the c.c. in the mixture of suspension and serum.

Contrary to the experience of some workers, it was found that suspensions made from growth on a medium containing ascitic fluid were not markedly less agglutinable than suspensions made from a growth on simple nutrient agar.

Conduction of agglutination tests.

The macroscopic method was always employed. The serum was diluted to strengths of 1:50, 1:100, 1:200 and 1:400; thus, when an equal quantity of coccal suspension was added, the serum was present in double this dilution, viz., 1:100, 1:200, 1:400, and 1:800. Sera were not tested in higher dilution. Half a cubic centimetre of each dilution was placed in a set of small test tubes arranged in series, and to each was added half a cubic centimetre of the suspension of the coccus to be tested. Racks holding the tubes were placed in an incubator at 55° C. for 24 hours, after which they were taken out and allowed to stand for 24 hours before reading the results.

Results of the Investigation.

Details respecting persons found to be carrying organisms indistinguishable from the meningococcus.

The following table (Table I) gives certain details respecting the persons yielding colonies in the primary plate which resembled the meningococcus. The numbers in the left-hand column were given in sequence to each person in the order examined. In the column headed "Sugar reactions" G > M indicates that stronger acidity was produced with glucose than with maltose, while M > G indicates the reverse. G = M means equally marked acidity with the two sugars.

In the column headed "Highest agglutination" the arabic numerals indicate the highest dilution giving complete agglutination, while MI, MXIII, NP 108, etc., refer to the different monovalent sera with which this result was produced. *Vide* Table V for the agglutinating properties of these towards meningococci of cerebro-spinal origin.

TABLE I.

Details respecting persons yielding colonies in the primary plate which resembled the meningococcus.

No.	Date.	Sex.	Age.	Physical condition.	Locality.	Urban or Rural.	No. of colonies on original plate	Sugar reaction.	Sub-cultures.	Highest agglutination.
7	13 vi., 16 ...	F.	34	Phthisis	Cambridge ...	U.	Many ...	G. > M.	Like meningococcus	800 (M. i., etc.).
12	15 vi., 16 ...	M.	29	,, ...	Cambridgeshire	R.	Almost pure	M. > G.	,,	50 (M. i.).
13	,, ...	M.	24	Mitral disease ...	Cambridge ...	U.	Almost pure	M. ≥ G.	,,	800 (M. i., etc.).
18	17 vi., 16 ...	F.	43	Normal	Ely	R.	Many ...	G. > M.	,,	800 (M. i., etc.).
20	,, ...	F.	48	,, ...	Cambridgeshire	R.	Many ...	G. = M.	,,	800 (M. i., etc.).
29	,, ...	F.	45	,, ...	,,	R.	Many ...	G. = M.	Colonies yellow ...	Nil.
32	19 vi., 16 ...	M.	53	,, ...	Cambridge ...	U.	Many ...	G. ≥ M.	Like meningococcus	400 (M. xiii., N.P. 108).
60	5 vii., 16 ...	M.	49	Ophthalmia	,, ...	U.	Large proportion	G. = M.	Colonies yellow ...	Nil.
65	,, ...	M.	74	Normal	,, ...	U.	Large proportion	?	Like meningococcus	800 (M. i, etc.).
68	,, ...	F.	74	,, ...	Ely	U.	Few ...	Ferments saccharose	Yellow colonies ...	Nil.
70	,, ...	M.	13	,, ...	Cambridgeshire	R.	Few ...	G. = M.	Like meningococcus	800 (M. i., etc.).
76	7 vii., 16 ...	M.	12	,, ...	Cambridge ...	U.	Many ...	?	Strain lost	?
77	,, ...	F.	41	,, ...	,, ...	U.	Few ...	M. > G.	Like meningococcus	Nil.
90	10 vii., 16 ...	M.	6	,, ...	Cambridgeshire	R.	Many ...	Ferments saccharose	Yellow colonies ...	,,
96	,, ...	M.	6	Tonsils, etc., etc. ...	Cambridge ...	U.	,, ...	,,	Like meningococcus	,,
97	,, ...	M.	13	Normal	,, ...	U.	,, ...	G. = M.	Died	?
99	,, ...	F.	7	Congenital syphilis ...	,, ...	U.	,, ...	?	Like meningococcus	800 (M. iv., etc.).
100	,, ...	M.	4	Adenoids	,, ...	U.	,, ...	Ferments saccharose	Colonies yellow ...	Nil.
101	12 vii., 16 ...	M.	29	Phthisis (early) ...	Patients at	Open air	,, ...	G. = M.	Like meningococcus	800 M. iv., etc.).
106	,, ...	M.	20	,, (advanced)	Bourn Tuber-	life.	Few ...	G. > M.	,,	800 (M. iv., etc.).
108	,, ...	M.	22	,, (advanced)	culosis colony	R.	Almost pure	G. > M.	,,	800 (M. i., M. iv.).
109	,, ...	M.	13	,, (early) ...	Cambridge-		Few ...	M. > G.	,,	200 (N.P. 108).
112	,, ...	M.	17	,, (early) ...	shire.		Pure culture	M. > G.	,,	200 (M. xv., N.P. 108).
117	19 vii., 16 ...	M.	70	Normal	Cambridge ...	U.	Many ...	M. > G.	,,	800 (M. i., etc.).
121	,, ...	F.	49	,, ...	,, ...	U.	Few ...	?	Died	?
122	,, ...	M.	61	,, ...	,, ...	U.	Many ...	M. > G.	Like meningococcus	Nil.
129	,, ...	M.	8	Keratitis	,, ...	U.	Almost pure	M. > G.	,,	,,
131	,, ...	M.	75	Normal	Cambridgeshire	R.	One colony	M. = G.	,,	400 (M. xv., N.P. 108).
136	21 vii., 16 ...	F.	21	,, ...	Cambridge ...	U.	Many ...	M. = G.	,,	,,
139	,, ...	M.	18	,, ...	St. Ives ...	R.	Few ...	Ferments saccharose	Colonies yellow ...	50 (M. xvi.).
141	,, ...	M.	49	,, ...	Cambridgeshire	R.	,, ...	M. > G.	Like meningococcus	800 (M. i., etc.).

No.	Date.	Sex.	Age.	Physical condition.	Locality.	Urban or Rural.	No. of colonies on original plate	Sugar reaction.	Sub-cultures.	Highest agglutination.
146	21 vii., 16	F.	78	Normal	Cambridgeshire	R.	Many ...	G. = M.	Like meningococcus	Nil.
148	"	M.	14	"	"	R.	Few ...	G. = M.	Contaminated and outgrown	?
149	24 vii., 16	F.	5	"	Cambridge ...	U.	Few ...	?	Colonies yellow. Strain lost	?
150	"	M.	10	"	" ...	U.	Many ...	?	Like meningococcus	400 (M. i., etc.).
153	"	F.	26	"	" ...	U.	Large proportion	?	Like meningococcus	800 (M. xiii.).
155	"	F.	38	"	" ...	U.	Large proportion	?	Colonies yellow ...	Nil.
161	29 vii., 16	F.	15	"	Cambridgeshire	R.	Few ...	?	Died	?
164	"	F.	8	"	"	R.	Many ...	G. = M.	Colonies yellow ...	Nil.
172	31 vii., 16	M.	12	"	Royston ...	U.	Many ...	G. = M.	Like meningococcus	800 (M. i., etc.).
174	"	F.	16	"	Cambridge ...	U.	Many ...	G. = M.	Contaminated and outgrown	?
178	"	F.	27	"	" ...	U.	Many ...	?	Died	?
179	10 viii., 16...	M.	32	"	" ...	U.	Large proportion	G. > M.	Like meningococcus	800 (M. xiii.).
181	" ...	F.	25	"	Cambridgeshire	R.	Few ...	?	Like meningococcus Died	?
182	" ...	F.	36	Phthisis (early) ...	Cambridge ...	U.	Large proportion	G. > M.	Like meningococcus	800 (M. vi., M. xiii.).
183	" ...	M.	45	Phthisis	Cambridgeshire	R.	Large proportion	G. = M.	Died	?
184	" ...	M.	22	Normal	"	R.	Many ...	G. > M.	Like meningococcus	800 (M. i., etc.).
186	" ...	F.	15	Phthisis (early) ...	Cambridge ...	U.	Few ...	M. > G.	Yellow colonies ...	50 (N.P. 108).
188	" ...	F.	8	" ...	" ...	U.	Few ...	G. = M.	Like meningococcus	800 (M. xvi., M. xiii. N.P. 108.).
191	" ...	F.	38	Normal	" ...	U.	Large proportion	?	Died	?
196	15 viii., 16...	M.	69	"	Cambridgeshire	R.	Many ...	G. > M.	Like meningococcus	800 (M. xiii.).
198	" ...	M.	36	"	"	R.	Large proportion	?	Died	?
200	" ...	M.	56	"	"	R.	Many ...	?	Died	?
201	23 viii., 16...	F.	10	Lupus	Norfolk ...	R.	One colony	?	Died	?
202	" ...	F.	32	Asthma	Norwich ...	U.	Many ...	G. = M.	Like meningococcus	200 (N.P. 108).
204	" ...	F.	38	Anæmia	" ...	U.	Many ...	G. = M.	"	800 (M. xiii.).
207	" ...	F.	46	Normal	" ...	U.	Many ...	G. = M.	"	50 (M. xvi., M. xiii.).
209	" ...	F.	33	Syphilis	" ...	U.	Large proportion	G. = M.	"	200 (M. iv., N.P. 108, N.P. 235).

No.	Date.	Sex.	Age.	Physical condition.	Locality.	Urban or Rural.	No. of colonies on original plate	Sugar reaction.	Sub-cultures.	Highest agglutination.
211	23 viii., 16...	F.	25	Epilepsy	Norwich ...	U.	Almost pure	?	Died	?
212	„ ...	F.	51	Goitre	„ ...	U.	Many ...	G. = M.	Like meningococcus	800 (M xvi.).
214	„ ...	F.	11	Normal	„ ...	U.	Almost pure	G. = M.	„	800 (M. i., etc.).
216	„ ...	F.	26	Rheum. arthritis ...	„ ...	U.	Almost pure	G. = M.	Like meningococcus	800 (M. i., etc.).
217	„ ...	M.	45	Epilepsy	„ ...	U.	„	?	Died	?
222	26 viii., 16...	M.	32	Phthisis	„ ...	U.	Many ...	G. > M.	Like meningococcus	800 (N.P. 235).
223	„ ...	F.	50	Normal	„ ...	U.	Large proportion	G. = M.	„	800 (M. i., etc.).
224	„ ...	M.	8	Chorea	„ ...	U.	Few ...	M. > G.	Too adherent to medium to emulsify	?
227	„ ...	F.	30	Normal	„ ...	U.	„ ...	?	Adherent to medium	?
229	„ ...	F.	40	Normal	„ ...	U.	Almost pure	G. = M.	Like meningococcus	800 (M. i., etc.).
232	„ ...	F.	26	Chlorosis	„ ...	U.	Large	G. > M.	„	800 (M. xiii., N.P. 235).
235	„ ...	F.	45	Normal	„ ...	U.	Almost pure	G. > M.	„	800 (M. i., etc.).
236	„ ...	M.	65	Carcinoma	„ ...	U.	Many ...	G. = M.	„	400 (M. xiv.).
237	„ ...	M.	30	Normal	„ ...	U.	Almost pure	Ferments saccharose	Col. yellow ...	Nil.
238	„ ...	M.	15	Septic wound ...	„ ...	U.	Large proportion	?	Adherent	?
239	„ ...	M.	15	Normal	„ ...	U.	Many ...	?	Colonies yellow ...	?
242	„ ...	M.	18	Normal	„ ...	U.	Almost pure	G. = M.	Like meningococcus	800 (M. i.).
244	28 viii., 16...	M.	28	Deafness			Few ...	Ferments saccharose	Very adherent to media	Nil.
245	„ ...	M.	19	„	Soldiers under canvas at various camps and attending the Norfolk and Norwich Hospital for ear trouble.	All R.	Many ...	G. = M.	Like meningococcus	800 (M. xiii., N.P. 108, N.P. 235).
247	„ ...	M.	23	Otitis			„	G. = M.	„	800 (M. i., M. xiii.).
248	„ ...	M.	21	Deafness			„	G. = M.	„	Nil.
249	„ ...	M.	24	„			„	G. = M.	Very adherent to media	50 (N.P. 235).
250	„ ...	M.	30	Otitis			Almost pure	G. = M.	Like meningococcus	800 (M. i., etc.).
255	„ ...	M.	20	Deafness			One col. ...	?	Died	?
256	„ ...	M.	29	Otorrhœa			Few ...	G. = M.	Like meningococcus	800 (M. i., M. xiii.).
257	„ ...	M.	46	Normal	Norwich ...	U.	Many ...	G. = M.	Very sticky in subcult.	?
259	„ ...	F.	5	Otitis	„	U.	Few ...	G. = M.	Too adherent to make emulsion	?

No.	Date.	Sex.	Age.	Physical condition.	Locality.	Urban or Rural.	No. of colonies on original plate	Sugar reaction.	Sub-cultures.	Highest agglutination.
262	28 viii., 16...	M.	14	Normal	Norwich ...	U.	Large proportion	G. = M.	Like meningococcus	800 (N.P. 108).
264	,, ...	M.	18	,, ...	,, ...	U.	Few ...	G. = M.	Yellow colonies ...	Nil.
265	30 viii., 16...	M.	26	Epilepsy	,, ...	U.	Large proportion	G. = M.	Like meningococcus	200 (N.P. 108).
267	,, ...	F.	51	Myxœdema	,, ...	U.	,,	?	Adherent	?
268	,, ...	F.	18	Dyspepsia	,, ...	U.	Few ...	?	,, ...	?
271	,, ...	F.	29	Rheum. arthritis ...	,, ...	U.	Large proportion	?	,, ...	?
272	,, ...	F.	36	,, ...	,, ...	U.	,,	G. = M.	,, ...	200 (M. xv., N.P. 108).
276	,, ...	F.	35	Neurasthenia ...	,, ...	U.	Few ...	Ferments saccharose	,, ...	Nil.
279	,, ...	F.	15	Goitre	,, ...	U.	Many ...	?	Died	?
280	2 ix., 16 ...	M.	39	Phthisis	,, ...	U.	Few ...	?	,, ...	?
281	,, ...	M.	36	Sciatica	,, ...	U.	Almost pure	G. = M.	Like meningococcus	Nil.
282	,, ...	M.	27	Epilepsy	,, ...	U.	Large proportion	G. > M.	,,	800 (M. i.).
283	2 ix., 16 ...	M.	72	Apoplexy	,, ...	U.	Almost pure	G. = M.	Like meningococcus	100 (M. i., N.P. 235).
289	,, ...	F.	25	Neurasthenia ...	,, ...	U.	Large proportion	G. = M.	Tenacious growth would not emulsify	?
290	,, ...	M.	48	,, ...	,, ...	U.	,,	G. = M.	Like meningococcus	200 (M. xiv., M. xv.).
292	,, ...	F.	46	Retroflexed uterus ...	Norfolk ...	R.	One colony	?	Died	?
295	,, ...	M.	14	Normal	Norwich ...	U.	,,	G. = M.	Like meningococcus	200 (M. xv.).
296	,, ...	F.	14	,, ...	,, ...	U.	Almost pure	G. = M.	Colonies yellow ...	800 (M. xiii.).
297	,, ...	M.	50	Carcinoma of tongue	,, ...	U.	,,	?	Strain lost	?
299	,, ...	M.	9	Normal	Norfolk ...	R.	Large proportion	?	Adherent	?
305	12 x., 16 ...	M.	31	,, ...	Cambridge ...	U.	Three colonies	M. = G.	Like meningococcus	800 (M. ii., M. xiii.).
307	,, ...	F.	22	,, ...	,, ...	U.	Large proportion	G. > M.	,,	800 (M. i., etc.).
310	,, ...	F.	23	,, ...	,, ...	U.	Almost pure	G. = M.	,,	800 (M. xiii.).
312	,, ...	F.	22	,, ...	,, ...	U.	Large proportion	G. > M.	,,	800 (M. xiii.).
315	,, ...	M.	18	,, ...	,, ...	U.	Many ...	Ferments saccharose	,,	100 (M. i., M. xiii., N.P. 108).
317	,, ...	M.	24	,, ...	,, ...	U.	Almost pure	G. = M.	,,	800 (M. xiii., N.P. 108, N.P. 235).
318	,, ...	F.	16	,, ...	,, ...	U.	Large proportion	G. = M.	,,	200 (M. i., etc.).

No.	Date.	Sex.	Age.	Physical condition.	Locality.	Urban or Rural.	No. of colonies on original plate	Sugar reaction.	Sub-cultures.	Highest agglutination.
322	16 x., 16	M.	23	Normal	Cambridge	U.	Large proportion	G. = M.	Like meningococcus	800 (M. i., N.P. 108).
333	"	M.	25	"	"	"	Many	G. = M.	"	800 (M. xiii.).
334	"	M.	18	"	"	"	Few	G. = M.	"	400 (M. xiii.).
335	"	M.	16	"	"	"	"	G. > M.	"	800 (M. i., etc.).
338	"	M.	18	"	"	"	Many	G. = M.	"	100 (M. i., etc.).
339	"	M.	16	"	"	"	Almost pure	G. = M.	"	400 (M. i., M. xiii.).
341	"	M.	19	"	"	"	"	G. = M.	"	400 (M. xiii.).
342	"	M.	29	"	"	"	Few	G. = M.	"	100 (N.P. 108).
345	18, x., 16	M.	60	"	"	"	Many	G. = M.	"	800 (M. i., etc.).
347	"	M.	33	"	"	"	"	G. > M.	"	800 (M. i., etc.).
348	"	M.	28	"	"	"	"	G. > M.	"	800 (M. i., etc.).
349	"	M.	17	"	"	"	Almost pure	G. = M.	"	800 (M. xiii.).
350	"	M.	27	"	"	"	"	M. > G.	"	800 (M. i., M. xiii.).
351	"	M.	18	"	"	"	Many	G. = M.	"	200 (M. i.).
354	"	M.	17	"	"	"	"	M. > G.	"	800 (M. i., M. xiii.).
356	"	M.	18	"	"	"	Large proportion	G. = M.	"	800 (M. xiii.).
357	"	M.	15	"	"	"	Many	G. > M.	"	800 (M. i.).
358	18 x., 16	M.	20	"	"	"	Almost pure	G. = M.	"	800 (M. xiii. N.P. 108).
359	"	M.	23	"	"	"	Large	M. > G.	"	200 (M. i., N.P. 235).
361	"	M.	28	"	"	"	"	G. = M.	"	800 (M. i., etc.).
362	"	M.	21	"	"	"	"	G. > M.	"	800 (M. i., etc.).
366	23 x., 16	M.	30	"	"	"	Few	G. = M.	Died	?
369	"	M.	14	"	"	"	"	?	Colonies yellow: not tested further	?
371	"	M.	19	"	"	"	Almost pure	G. = M.	Like meningococcus	400 (M. i.).
372	"	M.	21	"	"	"	One colony	G. > M.	"	800 (M. i.).
375	"	M.	15	"	"	"	Large proportion	G. = M.	"	200 (M. i., N.P. 108).
384	"	M.	33	"	"	"	Few	G. = M.	"	100 (M. i., etc.).
386	25 x., 16	M.	23	"	"	"	Many	G. = M.	"	800 (M. i., etc.).
387	"	M.	29	"	"	"	Few	G. = M.	"	800 (M. i., etc.).
388	"	M.	19	"	"	"	"	G. = M.	"	800 (M. i., etc.).
391	"	M.	29	"	"	"	Almost pure	G. > M.	"	800 (M. i.).
396	"	M.	26	"	"	"	"	G. = M.	"	800 (M. xiii.).
397	"	M.	20	"	"	"	Many	?	Colonies yellow: not tested further	?
400	"	M.	21	"	"	"	Large proportion	G. = M.	Like meningococcus	800 (M. i.).

TABLE II.

Showing results obtained with each batch of swabs taken.

Date when collected.	Where collected.	Class of individual examined.	Number of strains resembling meningococcus in primary plate.	Strains shown to differ by cultivation, etc.	Strains died.	Strains examined for agglutinability.
1st hundred: June 13th—July 10th, 1916.	Cambridge, Addenbrooke's Hospital and Cambridge County Tuberculosis Clinic.	Eye out-patients and their friends. Tuberculosis patients and their friends.	18	6	2	10
2nd hundred: July 12th—Aug. 15th, 1916.	The same: also 16 swabs at tuberculosis colony.	The same ...	35	5	10	20
3rd hundred: Aug. 23rd—Sept. 2nd, 1916.	Norwich: Norfolk and Norwich Hospital.	Medical and surgical out-patients and their friends.	56	16	8	27
4th hundred: Oct. 12th—Oct. 25th, 1916.	Cambridge: Factory X.	Employees in normal health.	41	3	1	37

The proportion of positive results obtained, as shown in Table II, increased very considerably during the course of the investigation; this increase may be partly due to greater proficiency in taking swabs and to greater experience in detecting suspicious colonies. In the third batch, taken at Norwich, over 50 per cent. showed suspicious organisms in the primary plates; this number was considerably reduced on further examination, since many of the strains showed definite evidence of belonging to the catarrhalis type of organism rather than the meningococcus.

The analysis of results found in Table III is an attempt to show the influence of age, sex, health and surroundings on the proportion of meningococcus-like organisms found. The highest proportion seems to occur in young adult life, but it is also high in old people.

Amongst children a larger proportion of suspect organisms was obtained, but many of these could be differentiated from the meningococcus by cultivation and sugar tests, so that the number of positives in children was rather lower than in adults.

At every age suspicious colonies appear to be more commonly met with in males than in females.

There is some indication that persons with impaired health carry meningococcus-like organisms more frequently than those

in good health, and town dwellers more than country dwellers. But the figures suggesting this cannot be insisted upon, as the batches were taken at different times of the year and in different localities.

The general impression is obtained that a fairly high proportion of people of both sexes and all classes and ages can be shown to carry the organisms in question.

TABLE III.

Analyses of sex, age, surroundings and physical health of 111 *persons, from whose naso-pharynges were obtained organisms resembling meningococci in culture and sugar reactions.*

AGE AND SEX.

Age. Period.	−15		16–35		36–60		61–		All ages.	
	Total examined.	Positive.	Total examined.	Posi tive.	Total examined.	Positive.	Total examined.	Positive.	Total examined.	Positive.
Male ...	43	12 (28 %)	122	49 (40 %)	39	10 (26 %)	14	6 (42 %)	218	77 (35 %)
Female ...	29	5 (17 %)	71	14 (20 %)	71	13 (18 %)	11	2 (18 %)	182	34 (19 %)
Totals ...	72	17 (24 %)	193	63 (33 %)	110	23 (21 %)	25	8 (32 %)	400	111 (28 %)

HEALTH AND SURROUNDINGS.

	Total examined.	Positive.		Total examined.	Positive.
Town dwellers ...	267	85 (32 %)	Normal health ...	292	76 (26 %)
Country dwellers ...	133	26 (19 %)	Health impaired ...	108	35 (32 %)

Note: A few of the strains recorded in the above analyses were not fully tested owing to their having died (*see* Table I).

Certain interesting features may be recorded. The patients at Bourn Tuberculosis Colony were living a completely open-air life, and had been practically isolated from the general population for periods varying from a few weeks to six months. Out of 14 examined, 5 showed that organisms culturally and serologically resembling the meningococcus could be recovered from their naso-pharynges. From one of the strains occurring in a patient who had been in the sanatorium six months, a serum was prepared which agglutinated well both meningococci of cerebrospinal origin and other naso-pharyngeal strains.

A number of soldiers, all on service at camps in the country districts around Norwich, attended the hospital for deafness, ear discharge, etc., otherwise they were in good health. Out of 13 examined, 8 gave colonies like the meningococcus; of these strains one differed in fermenting saccharose, one was lost without

being tested, one resembled M. catarrhalis and four gave serological reactions similar to those given by the meningococci isolated from cases of the specific disease.

Amongst the employees at the factory, an interesting point came to light which may be of importance.

The factory contains three workshops fitted with lathes and other machinery. Two of the shops, which may be called A and B, have been built and been in use some years; the ventilation in these two shops is dependent mainly on the opening of windows at the will of the men working there; the cubic space per man, while quite in accordance with regulations, is not excessive. The third workshop, which may be called C, has been built within the last year; the machinery is new, and occupies a much smaller proportion of the cubic space than in workshops A and B; the shop is also much loftier than the earlier ones. Ventilation is effected not only by open windows but also by extracting fans and other modern devices, so that conditions in this respect may be said to be as perfect as possible. The cubic space per man is very large compared with workshops A and B. In the following table a comparison between the results found amongst the employees working in these workshops is shown. There are also added the results found amongst employees in the accounts department, the drawing office and other rooms where work demanding special technical skill is carried out. It may be stated that, on the whole, the employees in these last departments receive higher salaries, and consequently live in more comfortable and probably more hygienic home circumstances. It should be noted that five of the employees in these departments were women, whereas the employees in shops A, B and C were all men.

TABLE IV.

A comparison between results obtained amongst employees working under different conditions.

	Ventilation, etc.	Cubic space per man.	Number examined.	Number found positive.
Shop A ...	Windows: old building	682	39	24 (61 %)
Shop B ...	Windows: old building	642	11	6 (55 %)
Shop C ...	Fans, etc., windows: quite new building	2,249	17	4 (23 %)
Accounts Dept. drawing office, etc.	Various: all quite satisfactory: (5 of the employees were women).	?	15	1 (6 %)

It will be noted that a far higher proportion of positive results was obtained amongst employees working in the older, less ventilated workshops, where also cubic space was more restricted.

In view of the smallness of the figures it would be unwise to draw a too definite conclusion, but the results are suggestive.

Agglutination tests on strains collected.

Nine monovalent sera were prepared in the manner described above. These sera were utilised for testing the agglutinability

of all the cocci obtained during the investigation, and also were tested against certain undoubted meningococci isolated from the cerebro-spinal fluid of patients suffering from cerebro-spinal fever. These latter strains, which were given me by Dr. Scott, were chosen somewhat at random but included not only strains serologically like those predominating in the recent epidemics but also strains difficult to identify with either of the two main groups of meningococci.

The sera were prepared from the following strains:

MI.—A typical example of the serological group of meningococci, which has perhaps been found most commonly in recent epidemics. The titre of the serum prepared was 800. The strain used was obtained from Dr. Scott, who has designated it C.S. 16 and has found it typical of Group II.

MIV.—An example of the same group, shown by absorption tests to be practically identical with MI. The titre of this serum was about 600.

MVI.—An example of the same group. The serum did not give either with the homologous organism or with other members of the same group a sufficiently high titre, i.e., it did not give complete agglutination at dilutions above 1-200.

MXVI.—The serum from this organism was prepared by Dr. Griffith and used to test the strains I collected because it was a typical example of another common group of meningococcus. The titre of this serum was about 1,000. Dr. Griffith calls this strain M 43, and regards it as typical of Group I.

MXIV.—This coccus was apparently closely allied to MXVI; the titre was about 800.

MXV.—This coccus was allied to MXVI but showed definite differences when tested by absorption methods.

MXIII. This coccus was allied to the group of which MXVI is an example, but was not identical with it. The serum gave very variable results with suspensions prepared at different times and of different age.

NP 108.—Unlike the above, which were all prepared from cerebro-spinal fluid strains, this coccus was obtained from the naso-pharynx of a man of 22 who had been isolated in a tuberculosis open-air colony for six months, suffering from advanced phthisis. The coccus resembled the meningococcus very closely, and gave similar agglutination tests to the strains MI and MIV. The titre of the serum was about 400.

NP 235.—This was also a naso-pharyngeal coccus, and was obtained from a woman of 45 years of age in good health, living in Norwich. This coccus also resembled MI and MIV in its agglutinability. The titre of the serum was about 800.

In Table V are grouped the cross-agglutination tests between the test sera and certain meningococci of cerebro-spinal origin, amongst which are the cocci homologous to the sera.

Clear division into groups is not well established in this series. MI and MIV appear to belong to one group which gives consistent results with all the sera. MXV and MXVI also give evidence of being closely related to each other and of a different

TABLE V.

Cross-agglutination tests with 16 strains of meningococcus and monovalent sera prepared with 7 cerebro-spinal strains and with 2 strains of cocci obtained from the naso-pharynx resembling the meningococcus in culture and morphology.

		M. I.		M. IV.		M. VI.		M. XVI.		M. XIV.		M. XV.		M. XIII.		N. P. 108.		N. P. 235.	
	Normal rabbits serum, 1 : 50.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.
M. i.	—	c	800	c	400	c	100	—	—	±	50	∓	—	∓	—	c	400	c	800
M. ii.	—	c	800	c	400	c	100	∓	—	c	100	±	—	c	100	c	400	c	800
M. iii.	—	c	400	c	400	c	100	∓	—	c	100	∓	—	∓	—	c	800	c	400
M. iv.	—	c	400	c	400	c	100	±	50	c	100	∓	—	c	100	c	400	c	800
M. v.	—	c	800	c	800	c	200	—	—	±	50	c	100	c	400	c	800	c	400
M. vi.	—	c	800	c	800	c	200	—	—	c	200	c	400	c	800	c	800	c	400
M. vii.	—	c	800	c	800	c	200	c	100	c	200	c	400	c	800	c	800	c	400
M. viii.	—	c	800	c	800	c	800	c	400	c	800	c	800	c	800	c	800	c	800
M. ix.	—	c	400	c	400	c	100	c	200	c	100	c	100	c	800	c	400	c	200
M. x.	—	c	200	c	100	c	100	c	100	±	50	c	100	c	200	c	400	c	100
M. xi.	—	c	200	c	100	c	100	c	200	c	100	c	200	c	800	c	400	c	200
M. xii.	—	c	200	±	—	c	100	c	400	c	100	c	200	c	800	c	200	c	100
M. xiii.	—	c	200	c	100	c	100	c	400	±	50	c	200	c	400	c	400	c	200
M. xiv.	—	c	200	c	100	c	100	c	800	c	800	c	200	c	800	c	200	c	100
M. xv.	—	c	200	c	400	c	200	c	800	c	800	c	800	c	800	c	800	c	400
M. xvi.	—	±	50	c	400	c	200	c	800	c	100	c	800	c	200	c	100	±	—

c = agglutination complete. ± = agglutination well marked but incomplete. ∓ = agglutination slight but definite.

type from MI and MIV. But the intermediate strains give irregular results which make any classification impossible. The action upon these meningococcal strains of the sera prepared from naso-pharyngeal strains indicates that the latter were more nearly allied to MI and MIV than to MXVI, but hardly gives a basis for definite grouping.

The testing of a large number of strains by agglutination tests presents many technical difficulties. Chief amongst them is the variability of the coccus. Unless the sera are all prepared ready in anticipation, it is impossible to examine the cocci when recently isolated. On the other hand, if the strains are kept for different periods and then suspensions are prepared and examined all at one time against the necessary sera, it will be found that some of the strains do not agglutinate so well (if at all), as they did when first isolated. If, again, stock suspensions from the cocci are prepared immediately after isolation, it will be found that their agglutinability often increases as time goes on. Unfortunately, the extent to which both these changes may influence results is too irregular to be gauged. In these tests (Tables V and VI) the suspensions were generally prepared soon after isolation, and consequently there was often considerable delay before agglutination tests with the different sera were carried out. These facts must be borne in mind in reading the results of the action of sera on naso-pharyngeal strains.

Table VI shows the action of the same set of sera on cocci isolated from the naso-pharynx. If this table be compared with the previous one giving the action of the same sera on meningococci of cerebrospinal origin, it will be found that the results obtained with the naso-pharyngeal cocci can be roughly matched in a large proportion of instances with results obtained with the former. Very many match well with the results obtained with the group of meningococci represented by MI and MIV. There are a few, however, which give little or no agglutination with any of the sera tested.

TABLE VI.

Cross-agglutination tests with 94 strains of cocci, obtained from the naso-pharynx and resembling meningococci, and monovalent sera prepared from 7 cerebro-spinal strains and 2 naso-pharyngeal coccus strains.

Strain.	Normal rabbit serum, 1 : 50.	M. I.		M. IV.		M. VI.		M. XVI.		M. XIV.		M. XV.		M. XIII.		N. P. 108.		N. P. 235.	
		Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.
7	—	c	800	c	800	c	200	±	—	c	200	∓	—	c	800	c	800	c	400
12	—	±	50	±	—	±	—	—	—	∓	—	∓	—	∓	—	±	—	±	50
13	—	c	800	c	800	c	800	—	—	c	400	c	800	c	400	c	800	c	800
18	—	c	800	c	800	c	800	—	—	c	800	c	800	c	800	c	800	c	800
20	—	c	800	c	800	c	800	∓	—	c	800	c	800	c	800	c	800	c	200
32	—	c	200	c	200	c	100	±	50	c	100	c	200	c	400	c	400	c	200
65	—	c	800	c	800	c	800	±	—	c	200	c	800	c	800	c	800	c	400
70	—	c	800	c	800	c	800	c	100	c	200	c	800	c	800	c	800	c	200
77	—	—	—	—	—	∓	—	—	—	∓	—	∓	—	∓	—	∓	—	c	100
99	—	c	100	c	800	c	800	—	—	c	200	c	200	c	800	c	800	c	400
101	—	c	400	c	800	c	200	∓	—	c	100	c	400	c	800	c	800	c	400
106	—	c	100	c	800	c	800	—	—	±	50	±	—	±	50	c	800	c	400
108	—	c	800	c	800	c	100	—	—	c	100	∓	—	c	100	c	400	c	200
109	—	±	—	—	—	—	—	±	—	∓	—	—	—	∓	—	c	200	c	100
112	—	c	100	±	50	c	100	±	50	c	100	c	200	c	100	c	200	c	100
117	±	c	800	c	800	c	800	∓	—	c	800	c	200	c	800	c	400	c	200
122	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
129	—	—	—	—	—	—	—	∓	—	—	—	—	—	∓	—	—	—	—	—
131	—	c	200	c	200	c	100	c	100	±	50	c	400	c	200	c	400	c	400
136	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
141	—	c	800	c	800	c	800	c	400	c	800	c	800	c	800	c	800	c	800
146	—	∓	—	—	—	—	—	∓	—	—	—	—	—	—	—	—	—	∓	—
150	—	c	400	c	200	c	200	—	—	c	200	c	200	c	800	c	400	c	400
153	—	c	200	c	400	c	400	—	—	∓	—	±	—	c	800	c	200	c	200

Strain.	Normal rabbit serum, 1 : 50.	M. I.		M. IV.		M. VI.		M. XVI.		M. XIV.		M. XV.		M. XIII.		N. P. 108.		N. P. 235.	
		Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.
172	∓	c	800	c	200	c	200	±	—	c	100	c	200	c	800	c	400	c	200
179	—	c	400	c	200	c	200	±	—	c	100	c	200	c	800	c	200	c	100
182	—	c	400	c	200	c	800	±	—	±	—	±	—	c	800	c	200	c	100
184	—	c	800	c	800	c	200	±	50	c	200	∓	—	c	200	c	400	c	400
188	—	c	200	c	200	c	200	c	800	c	200	∓	—	c	800	c	800	c	400
196	—	c	400	c	200	c	100	c	200	±	—	c	200	c	800	c	400	c	400
202	±	—	—	—	—	—	—	—	—	±	—	—	—	∓	—	c	200	—	50
204	—	c	400	c	200	c	100	±	50	±	—	±	—	c	800	c	100	c	200
207	—	∓	—	—	—	—	—	±	50	∓	—	—	—	±	50	±	—	∓	—
209	—	c	100	c	200	∓	—	—	—	—	—	±	—	—	—	c	200	c	200
212	—	∓	—	—	—	∓	—	c	800	±	—	∓	—	±	—	±	—	c	200
214	±	c	800	c	800	c	800	±	—	±	50	c	100	c	800	c	200	±	—
216	±	c	800	c	400	c	200	—	—	±	50	±	—	c	800	±	50	c	100
222	—	c	100	c	200	c	200	—	—	—	—	—	—	c	100	c	200	c	800
223	±	c	800	c	400	c	200	c	200	c	100	c	400	c	800	c	800	c	400
229	—	c	800	c	800	c	400	±	—	c	400	c	400	c	800	c	800	c	800
232	—	c	400	c	400	c	200	∓	—	±	—	c	200	c	800	c	200	c	800
235	—	c	800	c	800	c	200	—	—	c	200	±	—	c	800	c	800	c	800
236	—	∓	—	∓	—	∓	—	∓	—	c	400	±	—	±	—	±	—	c	200
242	—	c	800	c	400	c	200	∓	—	c	100	∓	—	∓	—	±	—	c	200
245	—	c	400	c	400	c	400	∓	—	c	200	c	200	c	800	c	800	c	800
247	—	c	800	c	400	c	200	—	—	c	400	c	200	c	800	c	400	c	200
248	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	±	—	∓	—
250	—	c	800	c	400	c	200	—	—	c	400	c	200	c	800	c	800	c	800
256	—	c	800	c	400	c	200	c	100	c	100	c	200	c	800	c	400	c	200
262	—	±	—	±	—	—	—	—	—	—	—	—	—	—	—	c	800	c	400
265	—	c	100	—	—	—	—	—	—	∓	—	∓	—	±	50	c	200	c	100
272	∓	—	—	—	—	—	—	∓	—	±	—	c	200	c	100	c	200	c	100
281	—	±	—	—	—	—	—	—	—	—	—	∓	—	—	—	∓	—	—	—
282	—	c	800	c	800	c	200	—	—	c	200	±	—	±	50	c	400	c	400

Strain.	Normal rabbit serum, 1:50.	M. I. Agglutination at 1 : 100.	M. I. Highest dilution with complete agglutination.	M. IV. Agglutination at 1 : 100.	M. IV. Highest dilution with complete agglutination.	M. VI. Agglutination at 1 : 100.	M. VI. Highest dilution with complete agglutination.	M. XVI. Agglutination at 1 : 100.	M. XVI. Highest dilution with complete agglutination.	M. XIV. Agglutination at 1 : 100.	M. XIV. Highest dilution with complete agglutination.	M. XV. Agglutination at 1 : 100.	M. XV. Highest dilution with complete agglutination.	M. XIII. Agglutination at 1 : 100.	M. XIII. Highest dilution with complete agglutination.	N. P. 108. Agglutination at 1 : 100.	N. P. 108. Highest dilution with complete agglutination.	N. P.235. Agglutination at 1 : 100.	N. P.235. Highest dilution with complete agglutination.
283	—	c	100	±	—	—	—	—	—	—	—	—	—	—	—	—	—	c	100
290	—	∓	—	±	—	—	—	±	—	c	200	c	200	c	100	∓	—	±	50
295	—	±	50	—	—	—	—	∓	—	c	100	c	200	c	100	∓	—	∓	—
305	—	c	200	c	800	c	100	∓	50	c	100	c	200	c	800	c	400	c	200
307	—	c	800	c	400	c	200	—	—	c	100	c	200	c	800	c	800	c	400
310	—	c	200	c	200	c	200	—	—	c	50	c	200	c	800	c	100	c	100
312	—	c	200	c	400	c	200	—	—	c	100	c	200	c	800	c	100	c	100
317	—	c	400	c	400	c	200	∓	—	c	100	c	400	c	800	c	800	c	800
318	—	c	200	c	100	c	200	—	—	c	100	c	100	c	100	c	200	c	100
322	—	c	800	c	400	c	100	∓	—	c	100	c	200	c	400	c	800	c	400
333	—	c	200	c	200	c	100	—	—	c	50	c	100	c	800	±	—	±	—
334	—	c	200	±	—	c	200	—	—	∓	—	±	—	c	400	c	100	∓	—
335	—	c	800	c	400	c	200	—	—	c	100	c	200	c	800	c	800	c	800
338	—	c	100	c	50	c	100	—	—	—	—	c	50	c	100	c	50	c	50
339	—	c	400	c	200	c	200	—	—	c	50	c	100	c	400	c	200	c	200
341	—	c	200	c	200	c	100	±	50	c	100	—	—	c	400	c	200	c	200
342	—	±	50	∓	—	±	50	—	—	—	—	—	—	∓	50	c	100	±	50
345	—	c	800	c	400	c	100	—	—	±	50	c	200	c	800	c	800	c	800
347	—	c	800	c	800	c	400	±	50	c	200	c	400	c	800	c	800	c	800
348	—	c	800	c	800	c	800	c	400	c	100	c	100	c	100	c	800	c	400
349	—	c	200	c	400	c	100	±	—	±	50	c	200	c	800	c	400	c	400
350	—	c	800	c	400	c	200	c	100	±	50	c	200	c	800	c	400	c	200
351	—	c	200	c	100	c	100	—	—	∓	—	c	100	c	100	c	100	±	50
354	∓	c	800	c	200	c	200	c	100	±	50	c	400	c	800	c	100	c	400
356	∓	c	400	c	200	c	200	c	100	c	100	c	200	c	800	c	400	c	200
357	—	c	800	c	400	c	100	∓	—	±	50	c	100	c	400	c	400	c	200
358	—	c	200	c	100	c	100	c	400	∓	50	c	200	c	800	c	800	c	400
359	—	c	200	±	50	±	50	c	100	—	—	±	50	±	50	±	—	c	200
361	c	c	800	c	800	c	800	c	800	c	100	±	50	c	400	c	800	c	800
362	—	c	800	c	400	c	100	—	—	±	50	∓	—	c	100	c	800	c	800

Strain.	Normal rabbit serum, 1 : 50.	M. I.		M. IV.		M. VI.		M. XVI.		M. XIV.		M. XV.		M. XIII.		N. P. 108.		N. P. 235.	
		Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.	Agglutination at 1 : 100.	Highest dilution with complete agglutination.
371	—	c	400	c	100	c	100	—	—	∓	50	c	100	c	200	c	100	∓	50
372	—	c	800	c	400	c	200	—	—	±	50	—	—	±	50	c	200	c	100
375	—	c	200	c	100	c	100	—	—	∓	50	c	100	c	100	c	200	±	50
384	—	c	100	c	100	c	100	—	—	∓	—	—	—	c	100	c	100	c	100
386	—	c	800	c	800	c	400	—	—	c	100	c	400	c	800	c	800	c	800
387	—	c	800	c	400	c	200	c	100	c	100	±	—	c	800	c	800	c	800
388	c	c	800	c	800	c	800	c	800	c	100	c	100	c	400	c	400	c	200
391	—	c	800	c	200	c	200	∓	—	c	100	c	100	c	400	c	200	c	100
396	∓	c	200	c	200	c	200	c	400	c	100	c	400	c	800	c	400	c	100
400	—	c	800	c	400	c	200	—	—	c	200	c	200	c	400	c	200	c	200

In considering these results it must be remembered that agglutination with an anti-meningococcus serum does not necessarily imply close relationship with the meningococcus, since other organisms, e.g., the gonococcus, may agglutinate well with anti-meningococcus sera. On the other hand, a coccus cannot be definitely established to have no relationship with the meningococcus because it is not agglutinated by any of the sera of a particular series. Other sera might be found, if a sufficiently long search were made, which would agglutinate it well.

TABLE VII.

Agglutination reactions of strains which in sub-culture or in fermentation reactions were distinguishable from the meningococcus.

Strain.	Normal rabbit serum 1:50.	M. I. Agglutination at 1:100.	M. I. Highest dilution with complete agglutination.	M. IV. Agglutination at 1:100.	M. IV. Highest dilution with complete agglutination.	M. VI. Agglutination at 1:100.	M. VI. Highest dilution with complete agglutination.	M. XVI. Agglutination at 1:100.	M. XVI. Highest dilution with complete agglutination.	M. XIV. Agglutination at 1:100.	M. XIV. Highest dilution with complete agglutination.	M. XV. Agglutination at 1:100.	M. XV. Highest dilution with complete agglutination.	M. XIII. Agglutination at 1:100.	M. XIII. Highest dilution with complete agglutination.	N.P. 108. Agglutination at 1:100.	N.P. 108. Highest dilution with complete agglutination.	N.P. 235. Agglutination at 1:100.	N.P. 235. Highest dilution with complete agglutination.	Differences from meningococcus.
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	∓	—	∓	—	Colonies yellow in sub-culture.
60	—	—	—	—	—	∓	—	—	—	∓	—	∓	—	∓	—	∓	—	∓	—	Colonies yellow in sub-culture.
68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Colonies yellow; ferments saccharose.
90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	∓	—	—	—	Colonies yellow; ferments saccharose.
96	—	∓	—	±	—	±	—	—	—	∓	—	∓	—	∓	—	∓	—	∓	—	Ferments saccharose.
100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Colonies yellow; ferments saccharose.
139	—	—	—	—	—	—	—	±	50	—	—	—	—	—	—	∓	—	—	—	Colonies yellow; ferments saccharose.
155	—	—	—	—	—	—	—	—	—	—	—	—	—	∓	—	±	—	∓	—	Colonies yellow.
164	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	∓	—	∓	—	Colonies yellow.
186	—	—	—	—	—	—	—	—	—	—	—	—	—	∓	—	±	50	∓	—	Colonies yellow.
237	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	±	—	∓	—	Colonies yellow; ferments saccharose.
244	—	—	—	—	—	—	—	∓	—	—	—	±	—	∓	—	—	—	∓	50	Ferments saccharose.
249	—	∓	—	—	—	∓	—	—	—	∓	—	—	—	—	—	—	—	∓	50	Unduly adherent to media.
264	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Colonies yellow.
276	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Ferments saccharose.
296	c	c	400	c	200	c	200	—	—	±	50	c	100	c	800	—	—	—	—	Colonies yellow.
315	—	c	100	∓	—	±	—	—	—	—	—	∓	—	c	100	c	100	∓	—	Ferments saccharose.

For purposes of comparison, in Table VII are given the results of the same set of sera on naso-pharyngeal cocci which could be distinguished by cultural or fermentation tests or both from the meningococcus. Many strains of the catarrhalis type are omitted owing to the impossibility of making a suspension suitable for the test.

Very few give any indications of agglutinability. No. 296 is an irregular organism which agglutinates with certain sera but also agglutinates completely with normal rabbit serum in a dilution of 1:50.

Absorption tests.

A positive absorption test with a given coccus is the best proof at present available that this coccus is identical with the meningococcus which produced the serum. The essential feature of the proof is the demonstration that, if a given dilution of an anti-meningococcus serum be brought in contact with a quantity of an unknown coccus which is just sufficient to remove the agglutinins that act on that coccus, it will also no longer agglutinate the homologous meningococcus. The test is carried out differently by different workers. I have followed as closely as possible the method proposed by Gordon and Murray.*

In this method the serum is diluted to 1:25 with saline, and an equal quantity of the standard suspension of cocci, as used in agglutination tests, is added; the mixture is then incubated for 24 hours at blood temperature. While this procedure was found to give satisfactory results with a few of my strains, I did not find that it worked well as a standard test, because in the case of many naso-pharyngeal strains the agglutinins acting on the test coccus were not removed to a sufficient extent, and this removal is an essential feature of the test. Gordon and Murray say: "should the result of an absorption test made in this way be at all doubtful, we then saturate the same serum over again and proceed as before. The first saturation sometimes clears off 'agglutinoids' very nicely from serum." It is evident that they have found the method with one "saturation" satisfactory only sometimes. If, now, as they state, a second "saturation" on the same serum is to be effected (presumably with the same standard suspension), it is difficult to see how they retain the same titration dilutions for the test, inasmuch as the serum must be diluted more than 1:100 when the final test is carried out.

To avoid this difficulty, and, while effectively removing the test coccus agglutinins, to employ as small an amount of the coccus in exhausting as possible, I adopted the plan of adding small quantities of a somewhat stronger suspension at definite intervals on three successive occasions, thus utilising the well-known fact that the same amount of suspension will remove agglutinins more effectively if it be added part at a time than if it be added all in one dose.

* "Identification of the Meningococcus," Major M. H. Gordon, R.A.M.C., and Mr. E. G. Murray, pp. 411–423, *Journal of the Royal Army Medical Corps,* Vol. xxv, No. 4, October, 1915.

The details of the method were as follows:—Small centrifuge tubes were placed in series in a rack. Into each tube 2·5 c.c. of a 1:25 dilution of the serum used in the test was placed. Sufficient serum should be left over for use as a control in the unabsorbed state. A convenient number of tests to carry out at one experiment was found to be sixteen. For this number, 50 c.c. of a 1:25 dilution of the serum was made up; the 16 tubes required 40 c.c. and 10 c.c. were left over for testing in the unabsorbed state. The suspensions for saturating the serum were prepared in the usual way in the strength of 10 milligrams to the cubic centimetre, and were heated at 65° C. for an hour. Into the first test tube was then introduced 0·5 c.c. of the 10 mg. suspension of the organism homologous to the serum; into the next one or two was introduced 0·5 c.c. of similar emulsions of meningococci serologically similar to the homologous organism; into another tube was introduced 0·5 c.c. of an emulsion of an organism known to be inagglutinable with the serum; then into the remainder of the tubes was introduced 0·5 c.c. of each of the strains of coccus to be tested. To the serum left over for controlling its effect in the unabsorbed state a similar proportion of phenol-saline was introduced, viz., one-fifth of its bulk. The tubes were then corked and placed in the incubator at 37° C. over night. The following morning the same process was repeated, and again in the evening; on the last occasion, when the final dose of emulsion was added, 1·0 c.c. of phenol-saline was also added to each tube, so that then the serum was fully diluted to 1:50. The serum for use in the unabsorbed state was also fully diluted in similar proportion. The titration was made on the following morning. Each of the tubes with suspension was centrifuged, and for each emulsion a rack was prepared containing ten agglutination tubes labelled *a* to *j* (*see* Table VIII). Into *a* was put 0·5 c.c. of the unabsorbed serum; into *b* was put 0·5 c.c. of the same serum diluted a half (now 1:100); into *c* and *d* were put the same amounts of 1:200 and 1:400 dilutions, respectively. Similar dilutions of the serum, after absorption by the coccus, were placed in tubes *e*, *f*, *g* and *h*. Into *i* and *j* were put the same dilutions as in *a* and *b*. The suspension used for the agglutination tests was prepared by diluting the stronger suspension used for absorbing, by adding four parts of phenol-saline to one of the strong suspensions, thus making a suspension of 2 mg. to the c.c. Into tubes *a*, *b*, *c*, *d*, *i*, and *j*, was put 0·5 c.c. of the coccus to be tested, and into tubes *e*, *f*, *g* and *h*, 0·5 c.c. of the suspension of the meningococcus homologous to the serum. The same process was carried out with the homologous meningococcus, the control cocci, and all the cocci under examination. The racks were then put in the incubator at 55° C. for 24 hours, and afterwards allowed to stand for 24 hours at room temperature before the results were read. In this method the serum is treated with 5 mg. of cocci in 3 c.c. of 1:30 dilution for about 15 hours, then with 5 mg. of cocci in 3·5 c.c. of 1:35 dilution for about 9 hours, and finally with 5 mg. of cocci in 5 c.c. of 1:50 dilution for about 15 hours.

This procedure resulted in the satisfactory removal of the agglu-

tinins acting on the test coccus in practically every instance. The amount of suspension used is very small, totalling 15 mg. of culture for 5 c.c. of a 1-50 dilution of serum or 3 mg. per c.c.

In Table VIII are given the results of absorbing MI serum with 30 naso-pharyngeal strains and 5 controls. These 30 strains all agglutinated with the serum when originally tested (Table I). Nineteen of them were obtained from the last 100 swabs (Nos. 301-400), which were taken from healthy workpeople at Cambridge. These are compared with ten strains from my Norwich cases (Nos. 201-300) and with one (No. 108) from the Bourn Tuberculosis Colony.

Special attention may be called to the strains from healthy workpeople. It will be seen from the table that nine of them absorbed the agglutinin completely and four absorbed it partially. From this series of 100 swabs, therefore, 13 per cent. supplied a strain which answered every test for cerebro-spinal meningococci.

Very similar results were obtained by absorbing the serum MIV with the same series of cocci; these results are not shown.

TABLE VIII.

Results obtained by absorbing an anti-meningococcal serum with 30 strains of cocci obtained from the naso-pharynx, compared with those obtained by absorbing the same serum with the homologous organism, other meningococci of a type similar to the homologous organism, and cocci of a different species.

	Strain.	Serum M. I.										Absorption.
		Without absorption.				After absorption.						
		v. Test coccus.				v. Coccus M.I.				v. Test coccus.		
		A. 1:100.	B. 1:200.	C. 1:400.	D. 1:800.	E. 1:100.	F. 1:200.	G. 1:400.	H. 1:800.	I. 1:100.	J. 1:200.	
Homologous ...	M. I. ...	c	c	c	±	—	—	—	—	—	—	Complete.
Positive controls	M. IV. ...	c	c	c	∓	±	∓	—	—	∓	—	"
	M. VI. ...	c	c	c	±	—	—	—	—	—	—	"
Negative controls	Gonococcus	c	c	±	—	c	c	c	∓	±	∓	Negative.
	Flavus ...	—	—	—	—	c	c	c	±	—	—	"
Naso-pharyngeal strains	N.P. 108 ...	c	c	c	±	—	—	—	—	—	—	Complete or practically complete.
	229 ...	c	c	±	∓	±	∓	—	—	±	∓	
	235 ...	c	c	±	—	—	—	—	—	∓	—	
	245 ...	c	c	∓	—	—	—	—	—	∓	—	
	247 ...	c	c	±	—	—	—	—	—	—	—	
	307 ...	c	c	c	c	∓	—	—	—	∓	—	
	345 ...	c	c	c	±	—	—	—	—	∓	—	
	348 ...	c	c	c	±	∓	—	—	—	±	∓	
	357 ...	c	c	c	±	—	—	—	—	—	—	
	362 ...	c	c	c	c	—	—	—	—	∓	—	
	372 ...	c	c	c	c	∓	—	—	—	∓	∓	
	386 ...	c	c	c	c	∓	—	—	—	∓	—	
	387 ...	c	c	c	±	±	∓	—	—	∓	—	
	391 ...	c	c	±	—	∓	—	—	—	∓	—	
	242 ...	c	c	c	∓	c	±	—	—	∓	—	Partial.
	335 ...	c	c	c	∓	c	∓	—	—	±	∓	
	347 ...	c	c	c	c	c	±	—	—	c	—	
	400 ...	c	c	c	±	c	c	∓	—	c	∓	
	204 ...	c	c	∓	∓	c	c	c	∓	∓	—	Negative.
	223 ...	c	c	∓	—	c	c	c	∓	∓	∓	
	232 ...	c	c	∓	—	c	c	c	∓	∓	—	
	259 ...	c	c	∓	—	c	c	c	∓	∓	—	
	296 ...	c	∓	—	—	c	c	c	∓	—	—	
	317 ...	c	±	∓	∓	c	c	c	∓	∓	—	
	322 ...	c	c	c	±	c	c	c	∓	c	±	
	349 ...	c	c	∓	—	c	c	±	±	∓	—	
	350 ...	c	±	∓	—	c	c	c	∓	∓	∓	
	354 ...	c	c	±	—	c	c	c	±	±	—	
	356 ...	c	c	∓	—	c	c	c	±	∓	—	
	358 ...	c	c	∓	—	c	c	c	∓	∓	—	

Finally, the effect of saturating the two sera prepared from naso-pharyngeal strains was tested with 3 cerebro-spinal and several naso-pharyngeal strains. The results are shown in Tables IX and X, which may be considered together.

TABLE IX.

Results obtained by absorbing a monovalent serum prepared from a naso-pharyngeal strain with three strains of meningococci and fourteen strains of naso-pharyngeal cocci.

Strain.	Serum N.P. 108.									
	Without absorption.				After absorption.					
	v. Test coccus.				v. N.P. 108 coccus.				v. Test coccus.	
	A 1:100	B 1:200	C 1:400	D 1:800	E 1:100	F 1:200	G 1:400	H 1:800	I 1:100	J 1:200
N.P. 108 ...	c	c	c	∓	±	∓	—	—	±	∓
M. I.	c	c	c	∓	c	±	—	—	—	—
M. IV.	c	c	c	c	c	c	∓	—	±	±
M. VI.	c	c	±	—	c	±	—	—	∓	—
N.P. 235 ...	c	c	c	±	c	∓	—	—	±	—
307 ...	c	c	±	—	c	c	∓	—	±	∓
322 ...	c	c	±	∓	±	∓	—	—	±	±
335 ...	c	c	±	—	c	c	∓	—	∓	—
345 ...	c	c	c	±	c	c	—	—	c	∓
347 ...	c	c	c	c	c	c	∓	—	c	±
348 ...	c	c	±	∓	c	c	∓	—	∓	∓
350 ...	c	±	∓	—	c	c	c	—	—	—
357 ...	c	c	c	c	c	c	∓	—	∓	—
362 ...	c	c	c	∓	c	c	∓	—	±	∓
372 ...	c	c	c	∓	c	c	∓	—	c	±
386 ...	c	c	c	∓	c	c	—	—	±	±
387 ...	c	c	c	±	c	c	—	—	c	∓
391 ...	c	c	c	—	c	±	—	—	—	—

TABLE X.

Results obtained by absorbing a monovalent serum prepared from a naso-pharyngeal strain with three strains of meningococci, a strain of gonococcus and eleven naso-pharyngeal strains.

Strain.	Serum N.P. 235.									
	Without absorption.				After absorption.					
	v. Test coccus.				*v.* N.P. 235 coccus.				*v.* Test coccus.	
	A 1:100	B 1:200	C 1:400	D 1:800	E 1:100	F 1:200	G 1:400	H 1:800	I 1:100	J 1:200
N.P. 235 ...	c	c	c	±	±	—	—	—	±	—
M. I.	c	c	c	∓	c	c	∓	—	∓	—
M. IV.	c	c	c	∓	±	∓	—	—	∓	—
M. VI.	c	c	∓	—	c	±	∓	—	—	—
Gonccoccus ...	c	c	c	∓	c	c	c	∓	±	±
N.P. 108 ...	c	c	c	∓	c	c	∓	—	∓	—
307 ...	c	c	c	∓	c	c	±	—	∓	∓
322 ...	c	c	c	∓	c	c	±	—	∓	∓
345 ...	c	c	c	∓	c	c	∓	—	∓	∓
347 ...	c	c	c	±	±	±	∓	—	∓	∓
348 ...	c	c	±	∓	c	c	±	—	—	—
357 ...	c	c	c	±	c	c	±	—	—	—
362 ...	c	c	c	∓	c	c	∓	—	—	—
386 ...	c	c	c	∓	c	c	±	—	±	±
387 ...	c	c	c	±	c	c	∓	—	∓	—
391 ...	c	c	c	—	c	c	±	∓	∓	∓

With these sera it was found to be much more difficult to remove completely the agglutinin not only for the homologous strain but also for the test cocci, and it was found necessary to use for saturating 4·5 c.c. of the strong emulsion against 0·5 c.c. of the serum diluted 1:5; this is equivalent to 9 mg. of cocci per c.c. of a 1:50 dilution of serum. Even with this amount, as is shown in Table IX, the NP strains 345, 347, 372 and 387 left marked amounts of agglutinin for themselves as well as for the strain producing the agglutinin.

In such cases incomplete removal of the latter agglutinin may not indicate that the strain tested is specifically different from the agglutinin-producing strain, but it does indicate that a quantitative inferiority exists in the absorbing capacity of this tested strain as compared with others.

I have not met with the same phenomenon—difficulty in removing completely the agglutinin for the test coccus—among my sera prepared with strains of cerebro-spinal origin, but I am not prepared to erect this into a general distinctive feature of sera produced with naso-pharyngeal cocci.

It will be seen, however, that the meningococci of pathogenic origin, MI, MIV, and MVI, removed a large portion of the agglutinin for the NP coccus used in producing the serum, as also did those NP cocci which, as shown in Table VIII, removed completely the agglutinin from MI serum.

It will be observed further that, though NP 108 and NP 235 are apparently identical with MI since they absorbed its agglutinin completely, yet they are not identical with each other since the agglutinins they produced varied in their combining capacity for different strains. For example, NP 322 absorbed from serum NP 108 almost all the agglutinin for NP 108 itself, whereas from serum NP 235 it absorbed relatively poorly. On the other hand NP 347 behaved in almost exactly the reverse manner, absorbing NP 235 agglutinin and leaving agglutinin in the case of NP 108. These two strains NP 322 and 347 differed from both NP 108 and NP 235 in failing to absorb the agglutinin for MI (*vide* again Table VIII).

Results such as these make it difficult to rely upon the absorption test for determining the specific identity of strains of unknown pathogenicity with known pathogenic strains. Positive absorption results may be regarded as unequivocal; but negative results, as in the case of NP 322 and 347, may, as just indicated, be quite compatible with relationship to a pathogenic strain and this relationship may be clearly demonstrable by the use of other sera.

Summary.

1. In two areas in the Eastern Counties, Cambridge and Norwich, naso-pharyngeal swabs were taken from 400 individuals, who represented different conditions of health and social circumstances.

The investigation was made at Cambridge between the months of June and October, 1916, and at Norwich during August, 1916.

Owing to the low incidence of cerebro-spinal fever in the two towns during the year 1916 (see p. 160), the general population may be regarded as practically "non-contact" in respect of this disease.

2. As a result of the investigation, strains giving all the cultural and microscopical tests of the meningococcus were obtained as follows:

(*a*) From 200 swabs taken at Addenbrooke's Hospital during June and July, 1917, mostly from normal people, 30 strains.

(*b*) From 100 swabs taken at the Norfolk and Norwich Hospital during August, from individuals mostly in impaired health, 27 strains.

(*c*) From 100 swabs taken in Cambridge during October, from factory employees, who were all in good health and mostly in comfortable circumstances, 37 strains.

3. Such strains were found more often in males of every age group than in females, and in adults more often than in children.

In regard to the influence of health and surroundings, the results of the investigation grouped together show a larger proportion amongst town dwellers than amongst country people and amongst people with impaired health than amongst the healthy.

General conclusions cannot, however, be drawn from these figures because conditions were not always comparable. For

instance, the majority of country people were examined in June and July, when positive findings were low.

In examining the employees at a factory, I obtained the strains in a higher proportion from the men working in those shops where air space was more restricted and ventilation less perfectly effected.

4. The 94 strains collected from 400 naso-pharyngeal swabs were tested as regards their agglutinability against certain monovalent sera. These sera were prepared from seven strains of meningococci of cerebro-spinal origin, and from two of the naso-pharyngeal cocci which had been isolated during the course of the investigation. The meningococcal strains used for preparing the sera included strains which had been found identical with others occurring with considerable frequency in cerebro-spinal fluid and capable of being grouped in two main groups; they also included strains which differed from these and were apparently rarer; but there is no reason to assume that every variety occurring in the specific disease was represented.

The results of the tests on the above 94 strains may be classified as follows.:—

(*a*) 22 gave no agglutination above 1:100 with any of the sera used.

(*b*) 2 agglutinated well with certain sera, but also agglutinated with normal rabbit serum.

(*c*) 31 agglutinated up to 1-200 or 1-400 with the sera of a certain group (MI-MIV), and in some instances gave similar agglutination with other sera not belonging to this group.

(*d*) 39 agglutinated with the sera of the group MI-MIV to the full titre of the homologous strains, while with the sera belonging to other groups good agglutination was not often obtained.

This last group of 39 strains (41 per cent. of all tested) appears to be indistinguishable by simple agglutination tests from the MI-MIV group of cerebro-spinal meningococci. The previous group of 31 (33 per cent of all tested) shows evidence of serological relationship with meningococci of cerebro-spinal origin, but it is not possible on their agglutination tests alone to give an opinion as to their identity with any meningococcal group.

Agglutination tests as a whole indicated that about 74 per cent. of strains collected on account of their resemblance to the meningococcus in culture, gave evidence of relationship to the meningococcus in virtue of their agglutination reactions with anti-meningococcal sera.

5. In order to determine if the absorption test would corroborate the relationship shown by agglutination, absorption tests were done against a serum prepared by inoculation of a cerebro-spinal strain of meningococcus, MI, with all the strains, culturally and by simple agglutination indistinguishable from pathogenic meningococci, which had been collected from the last 100 swabs (normal factory employees, Cambridge). Nine absorbed the

agglutinin as well as the homologous coccus and four absorbed it partially.

Therefore, out of 100 normal people who had not been in contact with a case of cerebro-spinal fever, 9 per cent. were shown to be harbouring organisms in their naso-pharynx which were serologically identical with meningococci of pathological origin (cerebro-spinal fluid) and, in addition, 4 per cent., making 13 per cent. in all, were so closely allied as to be doubtfully distinguishable even by the test for absorption of agglutinin.

Similar results were obtained with strains obtained from Norwich.

The above results were confirmed by testing absorption by these cocci from another serum prepared with another spinal strain of meningococcus possessing properties almost identical with MI. I have not investigated absorption with sera prepared with strains which differ serologically from MI.

6. With regard to those naso-pharyngeal strains which were not identified with cerebro-spinal strains by serological tests (agglutination and absorption), I consider that in view of the great variation in the serological reactions shown by different strains of undoubted meningococci and even by different emulsions of the same strain, it is very difficult, if not impossible, to exclude any such microscopically and culturally typical organisms from the meningococcus group on the basis of serological tests.

VI.—Report on Organisms resembling Meningococci in the Naso-pharynx of Non-contacts; by C. J. Lewis, D.Sc., M.D., F.R.C.P.E.

(From the Pathological and Bacteriological Laboratory of the University of Birmingham.)

Object of Research.

This report deals with the result of the examination of four hundred and one persons resident in Birmingham, none of whom were known to have had opportunities of contact with cases of cerebro-spinal fever. Cultures were made from swabs from the naso-pharynx, and the organisms which resembled meningococci in their morphology and staining reactions were further investigated as to their cultural characters and their agglutination reactions.

They were compared with cultures of meningococci obtained from the cerebro-spinal fluid and from the naso-pharynx of cases of cerebro-spinal fever during the recent epidemic.

Standard Meningococci.

Meningococci from cases of cerebro-spinal fever.

The strains of naso-pharyngeal cocci from non-contacts have been compared with strains of meningococci from cases of cerebro-spinal fever.

The meningococci available for this purpose numbered twenty-eight; of these, sixteen were isolated from the cerebro-spinal fluid and two from the naso-pharynx in Birmingham, and ten were strains isolated from the cerebro-spinal fluid by Drs. Eastwood and Griffith, in London. Comparison was also made with six strains isolated in Birmingham from the naso-pharynx of persons who were contacts with cerebro-spinal fever. Only 22 of these 34 strains are included in the subsequent tabulations, as the others were not available for the whole series of tests.

These Birmingham organisms were identified by their morphology, staining reactions and cultural characters.

In films of the centrifuged deposit of the cerebro-spinal fluid the cocci were recognised by their morphology as diplococci which were bean-shaped and not of constant size. Films stained with thionine blue showed the diplococci either intracellular or scattered through the fluid. In many cases the cocci were found with much difficulty. Films stained by Gram's method showed the cocci consistently Gram-negative.

Cultures on glucose ox-serum from the deposit of the cerebro-spinal fluid provided films of Gram-negative cocci. These cocci varied greatly in size; they occured singly, in pairs or as tetrads, were frequently circular or irregular in shape, and did not always show the typical bean-shape. The cocci were differentiated by the stain, some showing deep colouration and others being of a faint pink colour.

In cultural characters on incubation at 37° C. for 24-48 hours these organisms all agreed in fermenting glucose and maltose presented to them in a solid medium composed of ox-serum, and containing neutral red as an indicator (1-100,000). Individual strains differed in the vigour of their action on these two sugars, some acting more on the one and some more on the other.

All the strains agreed in failing to ferment lactose, saccharose, laevulose and galactose.

At lower temperatures growth was restricted; none of the strains grew on gelatine or on ox-serum at 20° C. Of nine strains from cerebro-spinal fluid tested for growth on serum at 24° C. six showed no growth and three showed growth. Of four strains from contacts tested likewise, two showed growth and two showed no growth.

Colonies of these meningococci on glucose ox-serum slopes were large, colourless and soft. They looked watery, but to touch they exhibited a certain viscidity.

On plates of the same medium with neutral red, the colour of the colony was pink throughout and did not show deeper colour in the centre than at the periphery.

On placental serum agar plates, the colonies were large, raised, and of soft consistence. In shape the colonies were often

convex and rounded, and their colour pearly-grey. On touching with platinum wire the colonies were found to be somewhat slimy, and this test of consistence was valuable in distinguishing likely colonies of meningococci from organisms of the type of M. catarrhalis.

On Crowe's blood trypsin agar medium* in plates, the colonies of meningococci from the cerebro-spinal fluid were milky-white and of firm consistence.

Material.

The number of persons who were examined, and whose cultures are included in the subsequent tabulation, is four hundred and one.

Some of the swabs were taken by myself, but for the majority I am indebted to the kindness of others, especially to:—(1) Dr. Robertson, M.O.H. of Birmingham; the Assistant Medical Officers of Health (Dr. Davidson and Dr. Wood), and the Medical Staff of the City Hospitals (Dr. Whitehead, Dr. MacCallum and Dr. Valentine). (2) The Visiting Staff of the Ear and Throat Hospital, Birmingham, and in particular Dr. Glegg and Mr. Woodman. (3) Capt. Robb, R.A.M.C.

Of the 401 persons examined, 363 (90·5 per cent.) were over and 38 (9·5 per cent.) were under 14 years of age. 204 were males and 197 females.

The period covered by the investigation was from 19th May, 1915, to 2nd February, 1917.

Of the 401 persons 254 (63·3 per cent.) were normal healthy individuals, and 147 (36·7 per cent.) suffered from various ailments.

Collection of Sample.

A sample of naso-pharyngeal secretion was taken by sterile swab. Special swabs were provided with instructions as to their use. With each swab was supplied a culture medium for immediate inoculation, and the cultures were removed at once to the laboratory and incubated at 37° C.

The primary medium in 351 cases was solely glucose ox-serum in tubes. In the other 50 cases the primary medium was placental serum agar in plates, but in these 50 cases the swab was subsequently rubbed over glucose ox-serum in tube, so that this medium was used for all cases.

Method of Examination.

After one night's incubation the cultures were examined for Gram-negative cocci. A general film was made from the growth on the glucose ox-serum tube and stained by Gram's method. If the films showed Gram-negative cocci the tube was further inspected. After some experience it was found that by inspection a portion of the culture might be recognised as likely to be

* *The Lancet*, 1915, Vol. 2, p. 1127.

composed of Gram-negative cocci. A film from such a portion would be stained, and if it showed a large proportion of Gram-negative cocci that part of the culture would be selected for plating. The organisms that were subsequently found to have the fermentative properties of meningococci appeared on the glucose ox-serum tubes as moist, soft, colourless growth which proved somewhat viscid on touch with a platinum wire. A growth similar in appearance but of watery consistence may be deceptive until stained, when its organism is found to be Gram-positive and streptococcal.

The method of isolation of the Gram-negative cocci from the ox-serum tube consisted of preparing an emulsion of the growth in sterile normal saline and in spreading plates with this emulsion. The plates for this purpose were made either of glucose neutral red serum, placental serum agar, or of Crowe's trypsin blood agar.

The spreading of the plates was done with a platinum spreader, and one or two plates were used for each emulsion. If it was believed that the Gram-negative cocci were plentiful in the emulsion one plate was considered sufficient; in all other cases two plates were spread. At the time of plating out the serum culture a fresh subculture upon serum was also inoculated. When the primary medium was placental serum agar in plates, one such plate was inoculated with the swab immediately after the swabbing of the naso-pharynx. The distribution of the material over the surface of the plate was deferred until arrival at the laboratory. The material was spread with a platinum spreader over the original plate and, if sufficient, also over a second plate of the same medium. In no case was it found necessary to use three plates.

The plates were incubated at 37° C. for 24 hours. Individual colonies on the plates were then examined, and as a rule discrete colonies were available for this purpose, but occasionally the plates were overgrown and useless. In such cases replating from the serum tube or from its subculture was done. A colony of each kind on the plate was selected, and films were made and stained by Gram's method. Colonies composed of Gram-negative cocci were subcultured on glucose ox-serum.

In the early stages of the work subcultures were made from all kinds of Gram-negative cocci, but later only those were subcultured which showed no pigmentation.

On glucose neutral red serum the colonies which were subsequently found to give the fermentative reactions of the meningococcus possessed the following characters:—A somewhat profuse growth pink in colour, individual colonies raised, convex, circular, large and viscid to the wire.

On placental serum agar plates the colonies possessed much the same characters as already noted in the colonies of meningococci from cerebro-spinal fluid.

On Crowe's trypsin blood agar, when used for the primary isolation of naso-pharyngeal strains from contacts or non-contacts, the colonies appeared as transparent, rather flat discs.

Cultural Tests.

When a pure culture of a Gram-negative coccus had been obtained it was subjected to a series of cultural tests. These tests were:—(1) Growth or no growth on glucose ox-serum at 24° C. (2) Growth or no growth on gelatine at 20° C. (3) Fermentation or otherwise of the following substances, viz., lactose, glucose, saccharose, maltose, laevulose and galactose. These sugars, in a proportion of 1 per cent., were incorporated in a solid ox-serum medium impregnated with neutral red (1-100,000).

Gram-negative diplococci which in fermentation tests corresponded with meningococci were reserved for serological tests and temporarily regarded as meningococci.

It was observed that there was some difference in the way in which these strains fermented glucose and maltose. The reaction was sometimes more intense with maltose than with glucose; less often the reverse was noted, and there were some strains in which no difference could be detected in the degree of activity upon these two sugars.

Strains long subcultured did not always clearly reproduce the relative differences in fermentative capacity observed upon their first isolation.

Preparation of Sera.

For the preparation of agglutinating sera from strains of the meningococcus and allied organisms the rabbit was selected as the animal to be used, and intraperitoneal injection of vaccine was selected as the method.

It was found that normal rabbit serum did not agglutinate these organisms, but that agglutinating sera could be obtained from the rabbit after inoculation. It was also found that sera of the highest titre were obtained when large doses of vaccine were inoculated weekly for four or five weeks; but the results varied with the particular rabbit and the particular organism used, and a serum with a high titre was not always obtained.

The vaccines were prepared by growing the organisms on placental agar or glucose agar slopes for 24 hours at 37° C. Emulsions were prepared with normal saline solution, and the organisms were counted in the usual way, so that the approximate strength of the emulsion in organisms per c.c. was known. The emulsion was heated for 1 hour at 60° C.; the organisms were ascertained by subculture to be dead; and the vaccine was preserved in the ice-chest.

The inoculations were performed with graduated doses, the first being the equivalent of one agar slope culture and averaging about 15,000 million organisms. The succeeding doses were multiples of the first, the fourth dose being four times the strength of the first. The serum obtained was heated at 55° C. for one hour and its titre was determined.

For some of the sera a slightly different method was employed. The organisms in the vaccine were not counted, and the vaccine was freshly prepared for each dose. The first dose consisted of the whole growth on one glucose agar slope at 24 hours; the second dose of two similar growths, and so on.

The titre of a meningococcal serum varies with the particular strain used, and with the particular rabbit used. Some of the strains appear to possess low agglutinogenic powers, as even in two or three attempts certain strains never yielded a serum of high titre. One strain of meningococcus was inoculated into two rabbits by exactly the same method, in the same dosage, and at the same intervals, but of the resulting sera one had a titre of 1-2,000 and the other of only 1-500.

Methods of Agglutination Tests.

The agglutination tests were all done by the macroscopic method but variations were introduced in regard to other details, some tests being done with living cultures and others with killed organisms, some at 37° C. and others at 55° C., some from cultures on glucose agar and others from cultures on placental agar without serum.

The method of testing the agglutination of living cultures at 37° C. was as follows:—The serum was diluted in graduated strengths with normal or half-normal saline and ·5 c.c. of each dilution was transferred to separate test tubes. A control tube of saline without serum was similarly furnished with ·5 c.c. Into each tube was rubbed up a small quantity of the culture from the slope medium. The preparation of the emulsion must be carefully done so as to obtain a smooth admixture, and to have in each tube an approximately equal number of organisms. The tubes were then incubated at 37° C. for one night, the result noted, the tubes left at room temperature for one night and a further reading taken of the results. No notable differences were found in the results on the second day from those observed on the first day. In some cases the temperature of incubation was 55° C. instead of 37° C.; the results were then recorded after one night.

The method which was followed with killed cultures consisted in the preparation of suspensions of the organisms in saline solution (·4 per cent). The strength of this suspension was ascertained by counting the organisms as in the preparation of a vaccine. The suspension was then heated at 60° C. for one hour and subsequently preserved in the ice-chest. Before use, a portion of the suspension required was diluted to a strength of about 4,000 million organisms per c.c.

The macroscopic test was conducted in a small capped test tube by adding to ·5 c.c. of the diluted serum ·5 c.c. of the prepared suspension and incubating the mixture at 55° C. for several hours. A control tube of saline and suspension was incubated for each test. The period of exposure to 55° C. varied from eight to fifteen hours, according to the time of day when the tests were done. After removal from 55° C. the tubes were left at room temperature for several hours. It was found that the results recorded soon after removal from 55° C. were seldom altered by later observations, and that agglutination was not increased on the second day.

Comparing the results by these different methods it was found

that on the whole the results with killed cultures at 55° C. showed the agglutination more distinctly. This method was followed in all the tests which I have tabulated.

In these agglutination tests the end-point has been taken as the highest dilution of the serum which gave agglutination, not the dilution with which complete agglutination was observed.

Results.

Material.

Cultures from 425 swabs from the naso-pharynx were examined, and 24 of these were excluded from further consideration for the following reasons:—10 showed so much overgrowth of other organisms as not to furnish a fair examination; 12 were repeats (2 from persons previously positive but now found negative); and 2 were found to have come from contacts with cerebro-spinal fever. Of the remaining 401 persons, 32 yielded organisms resembling meningococci; a percentage of 8.

Table I shows the distribution as to age and sex of the persons examined and the incidence of the positive results. The age classification is governed by school age, and stated as above or below fourteen years.

Table I.

	Males.		Females.		Totals.	
	Positive.	Negative.	Positive.	Negative.	Positive.	Negative.
Under 14	1	13	0	24	1	37
Over 14	23	167	8	165	31	332
Total ...	24	180	8	189	32	369
	11·7 per cent.		4 per cent.		8 per cent.	

Discrimination as to the state of health of the persons positive shows that 24 or 75 per cent. were normal healthy individuals, and that 8 or 25 per cent. were in attendance at the hospitals for ailments of various kinds.

As the investigation was spread over 2 years and the swabs were not taken continuously, there was a difference in respect of time. the first hundred swabs (9 positive) being taken in May-July, 1915; the second hundred (7 positive) in August-November, 1915; the third hundred (3 positive) in March-May, 1916; and the fourth hundred (13 positive) in November, 1916-February, 1917.

The persons examined were engaged in very varied occupations, but some special classes were included *e.g.*, the staffs at the City Public Health Department (clerical and otherwise), the staffs of the two City Fever Hospitals, out-patients at the Ear and Throat Hospital, recruits and munition workers. The third hundred were mostly female nurses in a hospital, and the fourth hundred were mostly recruits and munition workers.

As to the methods by which the positive results were obtained, it was found that of the 32 positive results the organisms were isolated in 24 cases from glucose ox-serum tubes, followed by plating on glucose neutral red serum, in 5 cases from glucose ox-serum tubes followed by plating on placental serum agar, and in three cases from placental serum agar plates; of the last three, one was obtained from the plate, though it was unobtainable from the serum tube inoculated from the same swab, and in the other two cases the tube also showed the same organism. Trypsin blood agar plates were used in addition to serum plates for certain cultures, and in all the 13 positive cases that were so treated the organisms were isolated by both methods. Experience showed that this trypsin blood agar medium greatly facilitated the isolation of these organisms from mixed cultures and would in future be preferred to the other media.

Cultural characters.

(1) *Incubation at 24° C.*—Of the 32 strains 6 showed growth on glucose ox-serum at 24° C. and 26 showed no growth.

(2) *Incubation at 20° C.*—None of the 32 strains could be cultivated on gelatine at 20° C.

Fermentation tests.

None of the 32 strains fermented lactose, saccharose, laevulose or galactose incorporated in a solid ox-serum medium with neutral red as an indicator.

All the 32 strains fermented glucose and maltose presented in a similar form. Eleven strains acted with more intensity on maltose, ten strains with more intensity on glucose; with the other eleven strains these two sugars were affected equally.

Serological tests.

The sera available for the tests numbered 18 and had been derived from:—(1) Meningococci isolated from cerebro-spinal fluid in cases of cerebro-spinal fever (7 strains); (2) Meningococci from the naso-pharynx in cases of cerebro-spinal fever (1 strain, "MP"); (3) Organisms resembling meningococci from the naso-pharynx of non-contacts (9 strains); (4) Meningococcus agglutinating serum from the Institut Sérothérapique et Vaccinal, Berne. The last was obtained at different times as a solid or a liquid serum.

The sera were used to define the agglutinability of (1) the meningococci already referred to as the standard strains, and (2) the organisms resembling meningococci isolated from the naso-pharynx of non-contacts in Birmingham and London.

The stated titre of the serum is the highest dilution with which a positive result was obtained with the homologous strain.

Table II deals with strains of meningococci from cerebro-spinal fever cases and two from contacts, viz., "MV" and "MG," and shows the extent to which these strains were agglutinated by the sera prepared from strains of meningococci.

TABLE II.

Cross-agglutination tests with 22 strains of meningococci and monovalent sera, prepared with 8 strains of meningococci from cases of cerebro-spinal fever.

Sera ...	MP	MC	MM	MW	MK	MB	MN	MCk
Titre ...	4,000	3,000	2,000	2,000	600	300	500	1,000
Strain—								
MP ...	4,000	3,000	2,000	2,000	300	50	50	100
MC ...	4,000	3,000	2,000	2,000	500	100	50	100
MM ...	4,000	3,000	2,000	3,000	300	100	50	50
MMg ...	2,000	500	500	1,000	100	—	300	300
*MG ...	3,000	1,500	500	2,000	400	—	50	300
MH ...	100	500	100	500	400	—	50	—
MB ...	100	—	100	100	—	300	1,000	800
MN ...	—	—	—	100	50	300	500	1,500
MCk ...	—	—	—	100	100	200	500	1,000
MT ...	—	—	500	500	—	—	50	50
*MV ...	200	100	100	100	—	50	100	300
MWt ...	100	—	—	200	—	50	—	100
M1 ...	3,000	3,000	2,000	1,500	300	20	—	
M8 ...	3,000	3,000	2,000	1,500	500	100	50	
M10 ...	4,000	3,000	2,000	2,000	500	100	50	
M11 ...	200	150	100	200	200	—	—	
M16 ...	400	500	100	200	50	—	—	
M18 ...	—	—	50	100	—	300	500	
M25 ...	2,000	3,000	2,000	2,000	100	100	—	
M27 ...	50	—	50	50	50	200	500	
M32 ...	—	—	100	50	50	300	200	
M33 ...	—	—	100	—	—	50	50	

* Strain from contact.

Analysis of Table II.

Consideration of the figures in Table II shows that the meningococci include strains which are fully agglutinated to the limits of the titre of the serum and strains which are either not agglutinated at all with these sera or are agglutinable only to a slight extent.

It is evident that there are two main groups amongst these meningococci. Group 1 includes the organisms agglutinated well by the sera MP (from a naso-pharyngeal strain), MC, MM, MW and MK (all from cerebro-spinal strains), and Group 2 includes the organisms agglutinated well by the sera MB, MN and MCk.

The meningococci thus allotted to Group 1 are:—MP, MC, MM, MMg, MG, M1, M8, M10, M25, i.e., nine out of twenty-two strains.

The lettered strains are Birmingham strains, and the numbered strains are London strains. With reference to the latter Dr. Griffith has kindly tested the sera MP and MC on his strains and confirmed the results, except in regard to the strain M25 which in his opinion belongs to another group.

The meningococci which constitute Group 2 are MB, MN, MCk, M18, M27 and M32, i.e., six out of twenty-two strains.

The remaining seven strains are not clearly defined in the grouping but MH, M11 and M16 are probably allied to the

first group. The other four strains show no special relationship to these two groups.

Table III deals with strains of organisms resembling meningococci, which were isolated from the naso-pharynx of non-contacts in Birmingham. It shows the extent to which these organisms were agglutinated by the eight sera prepared from strains of meningococci from cases of cerebro-spinal fever.

TABLE III.

Cross-agglutination tests with 22 strains of naso-pharyngeal Gram-negative cocci (culturally like meningococci) and monovalent sera prepared with 8 strains of meningococci from cases of cerebro-spinal fever.

Sera ...	MP	MC	MM	MW	MK	MB	MN	MCk
Titre ...	4,000	3,000	2,000	2,000	600	300	500	1,000
Strain—								
2 ...	2,000	1,500	1,000	2,000	200	20	100	100
362 ...	2,000	500	1,000	—	100	200	—	50
138 ...	1,000	1,500	1,000	2,000	200	20	100	100
366 ...	1,000	1,000	2,000	2,000	200	—	50	50
371 ...	1,000	500	1,000	1,000	—	50	—	600
136 ...	500	100	500	100	100	—	—	—
194 ...	500	500	50	500	300	500	100	—
331 ...	400	200	1,000	—	100	100	100	500
377 ...	300	500	2,000	500	200	100	100	100
379 ...	200	500	1,000	100	50	200	100	200
342 ...	100	100	1,000	200	—	—	500	1,000
258 ...	—	—	100	100	—	100	200	100
271 ...	—	—	—	—	—	300	2,000	100
300 ...	—	—	100	—	100	200	100	500
363 ...	—	—	100	—	100	50	400	—
388 ...	—	—	100	—	400	—	500	500
404 ...	—	—	100	50	100	100	500	100
168 ...	100	—	—	—	—	—	50	—
179 ...	100	—	—	—	—	20	50	—
361 ...	—	—	—	300	—	—	—	—
370 ...	—	500	100	500	—	—	50	—
384 ...	—	300	200	—	100	—	—	300

Analysis of Table III.

Consideration of the figures in Table III shows that the naso-pharyngeal organisms include strains which are fully agglutinable, and strains which are either not agglutinable or are agglutinable only to a very slight extent by meningococcal sera.

The organisms which agglutinate best with the sera of Group 1 (viz., sera MP, MC, MM, MW, and MK) are 2, 138, 331, 362, 366, 371 and 136. But as a general rule their agglutinability did not extend to the full titre of the sera.

Those which agglutinate better with the sera of Group 2 (viz., MB, MN and MCk) are 194, 258, 271, 300, 342, 363, 388 and 404.

The sera of Group 2 are not of such a high titre as the sera of Group 1, otherwise more differentiation might be shown.

There are two strains viz.:—377 and 379 which are agglutinated to some extent by most of the sera but not distinctively by either group.

There are five strains, viz.:—168, 179, 361, 370 and 384 which do not agglutinate well with any of the meningococcal sera.

Table IV deals with strains of meningococci (the same as in Table II) from cerebro-spinal fever cases and from contacts, and shows the extent to which these strains were agglutinated by the sera prepared from naso-pharyngeal organisms of non-contacts.

TABLE IV.

Cross-agglutination tests with 22 strains of meningococci and 9 monovalent sera prepared from organisms resembling meningococci from the naso-pharynx of non-contacts.

Sera	2	138	194	136	168	179	258	271	300
Titre	2000	2000	400	500	1000	500	1000	500	2000
Strain—									
MP ...	2000	1500	300	400	800	500	800	300	3000
MC ...	1000	2000	500	200	500	500	800	500	1500
MM ...	1000	2000	500	200	800	1000	500	500	1000
MMg ...	500	500	50	50	50	—	500	400	1000
*MG ...	1000	2000	500	50	—	—	400	300	600
MH ...	300	500	500	50	—	—	300	50	100
MB ...	100	100	—	—	300	—	400	100	100
MN ...	100	100	—	50	300	—	400	—	300
MCk ...	—	500	—	—	—	—	100	—	100
MT ...	—	50	300	—	—	—	500	50	100
*MV ...	—	—	—	100	300	50	300	100	100
MWt ...	—	—	—	500	50	100	500	300	300
M1 ...	500	500	300	100					
M8 ...	1000	500	300	100					
M10 ...	500	2000	200	200					
M11 ...	50	—	50	—					
M16 ...	500	500	100	—					
M18 ...	50	200	50	100					
M25 ...	2000	2000	500	200					
M 27 ...	100	100	—	—					
M32 ...	50	50	50	50					
M33 ...	50	50	—	—					

* Strain from contact.

Analysis of Table IV.

Consideration of the figures in Table IV shows that certain of these sera agglutinate well certain strains of meningococci, while having little or no effect on other strains.

Further some of these sera agglutinate the meningococci of Group 1 very well, and much better than any of the other strains.

For instance, the sera numbers 2, 138, 194, 258 and 300 agglutinate well all the nine organisms of Group 1, and the agglutinogenic properties of the organisms producing these sera therefore resemble those of the meningococci belonging to Group 1.

It is notable that sera 194 and 300 agglutinate well the meningococci of the first group, though the strains 194 and 300 agglutinated better with meningococcal sera of the second group than with those of the first group.

Table V deals with strains of naso-pharyngeal organisms resembling meningococci and isolated from Birmingham non-contacts. It shows the agglutination of these strains with sera prepared from some of them. The strains are the same as those in Table III and the sera are those used in Table IV.

TABLE V.

Cross-agglutination tests with 22 strains of naso-pharyngeal Gram-negative cocci and monovalent sera from 9 of the same strains.

Sera	2	138	194	136	168	179	258	271	300
Titre	2000	2000	400	500	1000	500	1000	500	2000
Strain—									
2 ...	2000	2000	500	100	500	600	2000	100	2000
136 ...	500	1000	500	500	300	300	1000	100	500
138 ...	2000	2000	500	100	500	500	2000	500	1000
168 ...	—	—	—	—	1000	300	500	200	200
179 ...	—	—	—	—	1000	500	500	100	200
194 ...	500	500	400	100	800	100	500	100	400
258 ...	—	—	100	100	500	400	1000	500	800
271 ...	—	100	—	—	500	300	500	500	500
300 ...	—	—	500	500	200	100	1000	—	2000
331 ...	—	—	100	500	—	500	50	—	50
342 ...	—	—	—	—	—	—	500	—	—
361 ...	—	—	50	—	300	300	1000	50	500
362 ...	50	—	300	500	800	100	—	300	1000
363 ...	50	100	—	50	—	—	300	—	—
366 ...	300	—	1000	50	1000	1000	1000	500	—
370 ...	300	—	100	100	—	—	100	—	—
371 ...	1000	2000	—	—	50	300	—	—	1000
377 ...	300	100	—	50	—	100	500	50	100
379 ...	300	—	100	50	500	300	—	—	300
384 ...	—	—	400	—	—	1000	—	—	—
388 ...	300	—	100	—	—	300	—	500	600
404 ...	—	—	300	50	—	—	50	—	—

Analysis of Table V.

The chief feature of Table V is the irregularity in the inter-agglutination of these strains. Some of the organisms go to the full titre of the sera, and others give agglutination only with low dilutions of the sera, or in some cases not at all.

The sera 2 and 138 affect the series of strains in much the same way, and while the strains 2, 138 and 371 are the only three that with these sera go to full titre, strains 136, 194 and 377 are fairly well agglutinated.

Serum 136 agglutinated well the strains 136, 300, 331 and 362.

Serum 194 which, with its own organism reaches a titre of 1-400, has agglutinated four other strains up to 1-500 and one strain up to 1-1,000.

Sera 168 and 179 are much alike in their influence on the series of strains, and agglutinate in some degree most of the strains.

Serum 258 with a titre of 1-1,000 agglutinates five strains to full titre, and two strains above that figure, viz., 2 and 128.

Serum 271 agglutinates four strains to its full titre of 1-500.

Serum 300 agglutinates well five strains.

Berne serum results.

The meningococcal agglutinating serum from the Institut Sérothérapique et Vaccinal, Berne, has been used to test many of the strains of meningococci and of the similar naso-pharyngeal organisms isolated in Birmingham.

This serum may be obtained in either a solid or a liquid condition and of these two forms it was found that the solid preserved better its agglutinating properties.

The stated titre of this serum is usually about 1-1,000, and it is believed to be a polyvalent serum.

Of the strains tested with this serum 14 were meningococci from cerebro-spinal fluid, 8 were naso-pharyngeal strains from cerebro-spinal fever cases or from contacts and 28 were naso-pharyngeal strains from non-contacts.

Of the 50 strains, 27 were agglutinated to the full titre of the serum and of these 27, 10 were meningococci from cerebro-spinal fluid, 1 was from the naso-pharynx of a case of cerebro-spinal fever, 4 were from contacts,* and 12 were naso-pharyngeal strains from non-contacts.

9 of the 50 strains were not agglutinated by the serum; of these 9, 2 were cerebro-spinal fluid strains and the other 7 were from non-contacts.

The remaining 14 strains were agglutinated to some extent, though none of them reacted with a dilution above 1-500.

Comparison of Serological Grouping of Birmingham and London Strains of Organisms Resembling Meningococci Found in the Naso-pharynx of Non-contacts.

By the kindness of Dr. Griffith, a series of 10 strains from London non-contacts was received at a time when many of the Birmingham strains had died. These strains he had found to be representative of both good and poor agglutinators in his naso-pharyngeal series. I had already prepared sera from meningococci and naso-pharyngeal organisms, and my object was to test these sera with the London strains and to discover whether these tests would disclose grouping of the organisms identical with the indications of grouping already found by Dr. Griffith.† If so, it would suggest the allotment of these sera according to the same groupings. It might be possible also to infer the probable groups to which the homologous organisms of each serum belonged.

Separate tables are subjoined showing the results of the tests of the London naso-pharyngeal strains with meningococcal and naso-pharyngeal sera from Birmingham strains.

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* Two of these contacts were soldiers, who carried meningococci home to their children. The children died from cerebro-spinal fever. From their cerebro-spinal fluids the strains MB and MW were obtained; and, with these, the sera MB and MW were prepared.

† See p. 45, Table II, of Dr. Griffith's report. (Report to the L.G.B., New Series, No. 110, 1916.)

TABLE VI.

Cross-agglutination tests with 10 strains of naso-pharyngeal Gram-negative cocci from London non-contacts and 7 sera from meningococci from cases of cerebro-spinal fever in Birmingham.

Sera	MP	MC	MM	MW	MK	MB	MN
Titre	4,000	3,000	2,000	2,000	600	300	500
Strain—							
NP 1 ...	1,000	1,500	1,000	1,000	50	50	100
NP 2 ...	500	300	500	500	100	100	100
NP 6 ...	200	—	200	50	100	400	2,000
NP 7 ...	50	—	100	100	50	200	50
NP 8 ...	50	—	—	—	50	400	200
NP 9 ...	100	300	500	50	50	100	1,000
NP 11 ...	—	—	100	50	50	300	200
NP 22 ...	100	100	500	100	—	300	2,000
NP 25 ...	50	300	100	—	100	50	100
NP 27 ...	50	50	50	—	—	—	—

The general conclusion from the figures in Table VI is that meningococcal sera produce definite agglutination with a large majority of these strains, and that the sera of Group 1 are somewhat less potent in this respect than the sera of Group 2.

To put it in another way, these particular strains appear to belong rather to Group 2 than to Group 1.

The organisms which agglutinate best with the sera of Group 1 (viz., MP, MC, MM, MW and MK) are Nos. NP1 and NP2, but neither of these are agglutinated at the full titre of the sera, though NP1 is affected by dilutions as high as 1-1,000 and 1-1,500.

The strains which agglutinate best with the sera of Group 2 (viz., MB and MN) are Nos. NP6, NP7, NP8, NP9, NP11 and NP22.

It is notable that with one of these sera, viz., MN, the strains NP6, NP9 and NP22 agglutinated at very high dilutions, much above the titre of the serum with its own organism.

With the serum MB two strains, viz., NP6 and NP8, agglutinated above the titre of the serum.

With these particular meningococcal sera the strains NP25 and NP27 agglutinated, but only to a slight degree.

These results agree closely with Dr. Griffith's, except that NP22 was not agglutinated by any of his meningococcus sera.

Table VII.

Cross-agglutination tests with 10 strains of naso-pharyngeal Gram-negative cocci from London non-contacts and 4 sera from similar organisms derived from Birmingham non-contacts.

Sera	2	138	194	136
Titre	2,000	2,000	400	500
Strain—				
NP 1	—	—	100	100
NP 2	50	—	300	200
NP 6	100	1,500	100	500
NP 7	500	1,000	500	50
NP 8	100	1,000	300	500
NP 9	100	—	—	50
NP 11	50	100	—	100
NP 22	100	100	100	100
NP 25	50	50	200	50
NP 27	50	50	100	50

Analysis of Table VII.

Table VII shows the extent to which London naso-pharyngeal strains were agglutinated by sera prepared with Birmingham naso-pharyngeal strains.

In a few cases the full titre of the serum is reached, e.g., by strains NP6 and NP8 with serum 136, while NP7 is agglutinated by serum 194 above the titre.

Serum 138 agglutinated in high dilutions strains NP6, NP7 and NP8.

On the whole the feature of the Table is the scarcity of negative results, and this seems to show that a general relationship exists between the London and Birmingham strains from non-contacts.

Conclusions.

(1) That in the naso-pharynx of non-contacts strains of Gram-negative cocci may be found which in microscopic appearance, in cultural characters and selective fermentation tests, correspond wholly with meningococci.

(2) That such strains include some which agglutinate with meningococcal sera, and which themselves produce sera which agglutinate meningococcal strains.

(3) That serological tests do not exclude the naso-pharyngeal cocci of non-contacts from the community of meningococci, but that on the other hand the tendency of these tests is to show some affinity of grouping between these organisms and the grouping of known meningococci.

(4) That the flora of the naso-pharynx of non-contacts in Birmingham include Gram-negative diplococci which bear a close resemblance to those found in the naso-pharynx of non-contacts in London.

(5) That in this particular series of 401 non-contacts organisms resembling meningococci were found more frequently in the male than in the female sex, the percentages being 11·7 for the male, 4 for the female, and 8 for the two sexes combined.

VII.—Report upon Meningococcus-like Organisms occurring in the Naso-pharynx of Children, and upon Meningococci of Spinal origin; by David Nabarro, M.D.

(From the Bacteriological Laboratory of the Children's Hospital, Great Ormond Street.)

Introductory.

The work was carried out in the Bacteriological Department of the Children's Hospital, Great Ormond Street, during the years 1915-16. It was intended to be supplemental to the investigations of Drs. Eastwood and Griffith, the Pathologists to the Local Government Board, and was undertaken under the auspices of the Board. Drs. Eastwood and Griffith were making an extensive examination of naso-pharyngeal swabs from patients not known to have been in contact with any cases of cerebro-spinal fever, mainly older children and adults attending St. Bartholomew's Hospital, and the task allotted to me was to make a similar investigation upon the children in the wards of the Great Ormond Street Hospital.

Technique.

The naso-pharyngeal swabs were all taken by myself from the patients in the wards of the Children's Hospital, Great Ormond Street, by means of a West's sheathed post-nasal swab.

In the case of children over six years of age the adult size of tube worked satisfactorily, but for younger children, in whom the naso-pharynx is shallow from above down, a smaller tube is desirable. These were made for me by Messrs. Maw, Son and Sons. It is not necessary to use a tongue depressor—in fact, it is better not to do so as it tends to make the patient retch—but the tongue is pressed down lightly by the swab tube as this is passed to the back of the mouth. The operation in the case of infants under eight or nine months is not an easy one, because the passage of the swab tube to the back of the throat frequently induces vomiting, which fills the naso-pharynx with milk and so contaminates the swab. Difficulty is experienced, too, in swabbing the throats of children who are suffering from cerebro-spinal meningitis, as owing to the rigidity of the muscles the little patients cannot be placed in the desirable sitting posture, and often from the same cause the mouth cannot be properly opened.

In order that my results might be comparable with those obtained by Drs. Eastwood and Griffith, I employed substantially the same technique as they did.

The material removed on the swab was immediately smeared over the central half of recently poured plates of Kutscher's medium. These were taken down to the laboratory without delay—usually within a quarter-of-an-hour—and there the mucus was smeared over the whole of the plate with an L-shaped platinum wire, which was then used for inoculating a second plate of the same medium. Owing to the difficulty experienced

in procuring a reliable peptone for the preparation of the Kutscher medium, Gordon's legumin trypsin agar with serum was used, in the latter half of the investigations, for the primary plates.

After incubation at 37° C. for 24 hours the plates were examined for "likely" colonies. Meningococci and meningococcus-like organisms in the naso-pharynx grow in the form of raised circular colonies, about ·5 to 1·5 mm. in diameter, regular in outline, translucent and bluish- or pearl-grey in colour. A small portion of such a colony was taken up on the point of a platinum needle, made into an emulsion and stained. If the organisms were typical Gram-negative diplococci, varying in size and in depth of staining, that is to say suggestive of meningococci, a subculture was made from the rest of the colony on a tube of Kutscher's medium. After 24 hours' growth at 37° C., further subcultures were made from this tube on (1) ordinary agar, at 37° C.; (2) nutrose- (or casein-) ascitic agar at 22° C.; (3) egg medium at 37° C., to keep the strain alive without the necessity of frequent subculture; and (4) Lingelsheim's solid media—litmus ascitic agar containing 1 per cent. of glucose, maltose, or saccharose—to test the production of acid. As the meningococci and meningococcus-like organisms in the naso-pharynx often grow in rather smaller and rather more opaque colonies than do the undoubted meningococci isolated from the cerebro-spinal fluid of cerebro-spinal fever cases, it was deemed advisable to test a number of such colonies which seemed suspicious by growing on agar at 37° C., on nutrose ascitic agar at 22° C., and for the fermentation reactions. Many of these proved to be not meningococci on cultural and fermentation grounds.

Material investigated.

Altogether 236 swabs were taken; of these 223 were from patients in wards of the Children's Hospital, and 13 from private cases. The 13 private cases comprised 12 boys (aged 12 to 16) from schools in which a case of cerebro-spinal fever had occurred, and a doctor who was attending a case of meningococcal meningitis; they all yielded negative results.

Of the 223 swabs taken from the children in the wards of the hospital, 7 were from cases of meningococcal meningitis, 5 were repeat swabs, and in 5 others the plates were overgrown with other organisms, so that the presence or absence of meningococci in them could not be determined. This leaves 206 cases to be considered in detail. The first 100 were examined between May 28th and October 15th, 1915, when the decline in the incidence of cerebro-spinal fever in England and Wales was already evident; they gave 7 positives. The last 106 were examined between January 16th and June 16th, 1916, and gave 6 positives.* Thirteen positive results were thus obtained in

* It had been hoped to examine a larger number of children during the decline of the cerebro-spinal fever epidemic of 1915, but the loss of a skilled laboratory attendant who joined the Army rendered this impossible.

206 cases, giving a percentage of 6·3. This number is considerably lower than that (10·2 per cent.) obtained in 1915 by Drs. Eastwood and Griffith from the swabs taken by Mr. West in the Aural Department of St. Bartholomew's Hospital, and very much lower than that (22 per cent.) obtained by Dr. Scott from the out-patients at the Lambeth Infirmary. The explanation may be found in the fact that all the patients under consideration here were under 13 years of age, as it may be the case that there are fewer "carriers" amongst children than amongst adolescents and adults. An analysis of Drs. Eastwood and Griffith's statistics appears to confirm this view. Of their 480 cases with 49 positives (10·2 per cent.), 79 were under 10 years of age with 5 positives = 6·3 per cent., which by a curious coincidence is exactly the percentage of positives obtained by me from 206 cases under 13 years of age. Similarly with Dr. Scott's statistics; only 19 of the 138 individuals examined by him (13·5 per cent.) were of 14 years or under, while 66 (47·8 per cent.) were of 50 or over. The large number (86·5 per cent.) of patients over 14 may in part account for Dr. Scott's very high percentage of positive results.

Cultural tests of naso-pharyngeal swabs from children.

Age Period.	Males.		Females.		Totals (M. & F.).	
	Positive	Negative	Positive	Negative	Positive	Negative
0 to 2 years	0	4	0	2	0	6
2 to 5 ,, ...	0	23	2	15	2	38
5 to 10 ,, ...	4	59	3	60	7	119
10 to 12 ,, ...	0	11	4	19	4	30
Totals	4	97	9	96	13	193
	4 per cent. Positive.		8·6 per cent. Positive.		6·3 per cent. Positive.	

An interesting fact, which may be an accident and for which I can offer no explanation, is that my percentage of positives from girls (8·6 per cent.) is more than double that from boys (4 per cent), whereas Eastwood and Griffith obtained 13·4 per cent. and 6·2 per cent. respectively from males and females of *all ages*, and 7·2 per cent. and 4·1 per cent. respectively from boys and girls under 10 years of age. The repeats of previous positives (4 in number) and of one doubtful case were all negative, but are too few in number to admit of any conclusion being drawn from them. The children examined were drawn from all the wards, medical and surgical, and were suffering from various ailments. It is a curious fact that the first "carrier" I discovered was a boy of six suffering from spastic paraplegia, who had only just landed in England from the Falkland Islands. The other positives were suffering from various diseases such as chorea, chronic rheumatism, abdominal tuberculosis, empyema, etc.; no two of them were suffering from the same disease.

Relation of positive results to cases of meningococcal meningitis in the wards.

At the Great Ormond Street Hospital no special precautions are taken to isolate cases of meningococcal meningitis, and it is the general opinion of the physicians on the staff that no case of the disease has ever been known to arise in the hospital when one or even more cases of the disease have been present in a ward. I examined the throats of 7 cases of meningococcal meningitis in children (aged from two months to five years) and isolated the meningococcus in one case only—an infant of three months. As four of the children were under one year, it is probable that the proportion of positives was higher than I found, namely one in seven, and that I missed some meningococci in naso-pharyngeal swabs, owing to the difficulties mentioned earlier in this paper.

As to the question whether my results corroborate the view of the medical staff of the hospital that quarantine measures are unnecessary, I may state that 32 batches (comprising 183 children) were examined in wards in which no cases of cerebro-spinal meningitis were present; of these, 173 children were negative and 10 were positive. The 10 positives were obtained from as many batches, for on no occasion were two carriers found in the ward at one examination. Four batches (comprising 26 children) were examined in wards in which one or more cases of cerebro-spinal meningitis were present. Of these, 21 children were negative and 5 were positive. One of the 5 positives was a case of cerebro-spinal meningitis; the other 5 children examined in the ward were negative as regards meningococcus-like organisms in the naso-pharynx. Of the remaining 4 positives, 2 were found in one ward in which there were 2 cases of cerebro-spinal meningitis, and 2 were found in another ward in which 1 case of this disease was present. It will be seen, therefore, that in the only two instances in which two "carriers" were found in a ward, one or two cases of meningitis were present in the ward at the time.

My observations are too few to justify any expression of opinion upon the question, but this aspect of the subject merits further investigation.

Cultural characters and fermentation reactions.

I have little to add to what is already known about the cultural characteristics of the meningococcus. In agreement with Dr. Scott, I, too, have found that the meningococci isolated from the cerebro-spinal fluid produce colonies which are usually larger and more translucent than the colonies of naso-pharyngeal meningococci or meningococcus-like organisms. On Gordon's legumin serum agar, the colonies of meningococcus are pearly-grey, as they are on Kutscher's medium, but may attain a larger size than on the latter medium. In one case some of the colonies of cerebro-spinal meningococci had attained a diameter of 4 mm. after three days' incubation at 37° C. From a considerable experience with both Kutscher's placental serum agar and Gordon's legumin serum agar (made with trypsinised heart broth), I have

come to the conclusion that Gordon's medium is as good as—if not superior to—Kutscher's, and safer to use at present, owing to the unreliability of the peptone available.

The thirteen naso-pharyngeal meningococcus-like organisms were tested for their power of fermenting glucose, maltose, and saccharose in sloped tubes of litmus ascitic agar containing 1 per cent. of these sugars. The tubes were usually inoculated from a culture on Kutscher's or Gordon's medium made the day previously from an original colony. Considerable variations in acid production were noted; of the 13, 8 fermented maltose and glucose equally; 3, glucose more strongly than maltose; and 2, maltose more strongly than glucose.

In no instance was saccharose fermented.

The acid fermentation of the sugars maltose and glucose, and failure to ferment saccharose, galactose and levulose, are generally held to be an important point in the diagnosis of the meningococcus, so that for comparative purposes I also tested the reactions of fifteen strains of meningococci of cerebro-spinal origin. I found that in 3 cases the sugars—glucose and maltose—were fermented equally and well; but that in the majority of instances they were unequally fermented, the balance being about even between those fermenting glucose best and those fermenting maltose best. In some of the cases the acid production was very slight and evanescent. It is, I think, important to mention that in 3 cases of undoubted cerebro-spinal meningococci, no trace of acid production from either glucose or maltose could be detected.*

Two other series of observations I was able to make are of interest in this connection.

A meningococcus isolated on August 19, 1915, from the cerebro-spinal fluid of an infant three months old, produced a fair amount of acid from glucose, but none—or only a trace—from maltose. Four days later I swabbed the naso-pharynx of this patient and isolated a meningococcus from the material obtained. The sugar reactions were the same as those of the spinal meningococcus. Nine days later, on September 1st, 1915, the ventricle was punctured through the fontanelle and a meningococcus isolated from the ventricular fluid. The sugar reactions this time were all negative, but the tests were made with a new batch of sugar media which may have been slightly more alkaline than the previous batch.† This case thus affords the interesting observation that meningococci isolated from the same patient within a fortnight showed a distinct difference in sugar-fermenting properties, and notably with glucose—a fair

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* Dr. Eastwood, to whom I sent for comparison the cultures in which I had found no acid production, confirmed my observation in two of the cases. In the third case he found that a sub-culture I sent him fermented glucose and maltose *very slightly*.

† This was the third case referred to in the previous footnote in which Dr. Eastwood found that the sub-culture, which I sent him six days later, fermented glucose and maltose *very slightly*.

amount of acid being produced on the first occasion, and none (or a slight trace only) on the second.

A similar result was obtained in a later case. A meningococcus isolated from the spinal fluid on June 19, 1916, fermented maltose well, and much more strongly than glucose. The meningococcus isolated a week later, again from the cerebro-spinal fluid, fermented maltose and glucose equally and well. The former of these cases had one intrathecal injection of anti-meningococcic serum, the latter had none; both patients died.*

How are these differences in the sugar reactions of the meningococci brought about? (1) They may be due to a modification of the original organism through contact with the human tissues, and as the result of the defensive mechanism elaborated by the infected individual. The possibility of modification has already been suggested by Dr. W. M. Scott in the Local Government Board's reports on Cerebro-Spinal Fever, 1916, (p. 67) in his endeavour to explain the varying agglutination reactions of naso-pharyngeal strains of meningococci isolated by him at intervals from the same patients. (2) One must also ask the question—and endeavour to answer it by observation—whether, in addition to the defensive substances elaborated by the patient which might modify the infecting meningococcus, the anti-meningococcic serum, injected by way of treatment, may not also play a part. (3) An alternative hypothesis—also suggested by Scott in the paper referred to above—is that in the naso-pharynges examined by him "the later swabs were furnishing cultures of another, perhaps a normal, inhabitant of the naso-pharynx which had been swamped by the infecting strain at the time of the first examination."

Similarly in cerebro-spinal meningitis, as suggested by Walker Hall and Peters, it is possible that several groups or strains of meningococci may be present, one strain predominating at one examination of the spinal fluid, and a second strain with different fermentative and agglutination reactions at another examination.

I have dwelt at some length upon the sugar reactions of the meningococci, because they are usually held to be of considerable diagnostic value in the identification of these organisms and their differentiation from allied cocci.

In the Local Government Board Reports on Cerebro-Spinal Fever, 1916, Dr. Griffith (p. 42) takes the view, which is that held by most, if not all, authorities upon the subject, that the

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* Since making these observations my attention has been drawn to a paper by Professor Walker Hall and Dr. B. A. I. Peters on the "Changes in the Agglutinability, Fermentation Reactions and Absorptive Capacities of the Meningococcus during the Acute Attack," in the Journal of the Royal Army Medical Corps, October, 1916. These observers report five cases of cerebro-spinal meningitis in which they studied, *inter alia*, the fermentation reactions of the meningococci isolated day by day from the cerebro-spinal fluid. In three of these cases there were obvious changes in the fermentative powers of the meningococcus; in two of them the organism lost the power of fermenting glucose, while in the third case the fermentative power seemed to be increased.

sugar reactions are next in order of importance to the appearances of the primary colonies as a means of identifying the meningococcus. Griffith found that the cocci recently isolated from the cerebro-spinal fluid usually fermented the sugars glucose and maltose unequally, whereas the naso-pharyngeal strains more often fermented these sugars equally. At first he thought that this difference in the behaviour of the true cerebro-spinal meningococci and the naso-pharyngeal meningococcus-like organisms would be a means of distinguishing the true meningococci from the so called pseudo-meningococci. Subsequent observations showed, however, that this distinction did not always obtain, for some of his recently isolated spinal meningococci fermented glucose and maltose equally. He also found that sometimes the acidity produced from glucose or maltose, or both, was very slight in amount and evanescent in character, but he and Dr. Eastwood state that, with their strains, there was always some acid formation with both glucose and maltose. From my own observations I am inclined to think that the fermentation of glucose and maltose by the meningococci, as ordinarily tested, is so variable in its results that rather too much reliance is placed upon this test. The following are my reasons for holding this view:

1. An appreciable number of undoubted meningococci of cerebro-spinal origin fail to give rise to acid fermentation of either glucose or maltose when first isolated from the patient.

2. All degrees of fermentative power are met with:—

(*a*) There may be failure to ferment glucose or maltose,
(*b*) One or other of these sugars may give rise to only a trace of acid, or
(*c*) They may be fermented equally and well.

3. The meningococci appear to be very sensitive to minute differences of reaction in the litmus sugar media. If these be slightly too alkaline the traces of acid which some strains are able to produce will not be made manifest by the litmus.

4. Meningococci isolated from the same patient at different times, even after only a short interval between the punctures, may exhibit distinct differences in their acid-producing power.

I am convinced that the first point mentioned above—that undoubted meningococci may, immediately after they are isolated, fail to produce acid from glucose and maltose, should be more widely known and appreciated. In my earlier observations on the naso-pharyngeal cocci I put out of court, as not being possible meningococci, any organisms which failed to ferment glucose and maltose. By so doing I may have missed, and probably did miss, some positive cases. The fourth point mentioned above may possibly be explained on the hypothesis suggested in the earlier part of this report. There is no doubt, I think, that with practice meningococci may be diagnosed with a considerable degree of assurance upon the macroscopic appearances of the primary colonies alone, and that the microscopic

and staining characteristics will help to strengthen the assurance. The diagnosis will be finally confirmed by the sugar reactions, the agglutination, and the absorption tests.

In conclusion, I would thank the physicians and surgeons on the staff of the Great Ormond Street Hospital for their permission to investigate the cases in their wards; Dr. Eastwood, for much valuable advice and for suggestions during the course of the investigation, and in connection with the preparation of this Report; and Drs. Griffith and Scott for many useful practical hints.

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EXTRACT

FROM THE ANNUAL REPORT OF THE

MEDICAL OFFICER

OF

THE LOCAL GOVERNMENT BOARD

For 1914–15.

REPORT ON THE

WORK OF INSPECTORS OF FOODS

For the Year 1914–15.

BEING

A REPORT BY

A. W. J. MACFADDEN, M.B.

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EXTRACT FROM THE REPORT OF THE MEDICAL OFFICER.

TO THE RIGHT HONOURABLE WALTER LONG, M.P., PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

SIR,

I HAVE the honour to submit the following report concerning the public health of England and Wales during the year 1914, and reviewing, for the year ending March 31st 1915, the work carried out under the general direction of your medical officer. In view of war conditions, the report has been greatly curtailed.

* * * * * * *

Protection of Food Supplies.—At the commencement of the war, the Board offered the War Office the assistance of their inspectors of foods. This offer was accepted, and at the desire of the Director of Supplies, Dr. MacFadden, the Chief Inspector of Foods, organised a system of special supervision over the preparation of army food supplies. The inspectors have since been continuously engaged in maintaining this system.

Information as to the sources of supply of food materials for army contracts was provided by the War Office, and by means of returns received from the Commanding Officer of the various units, details were also obtained as to regimental supplementary feeding arrangements. The place of preparation of all food materials was ascertained in this way, and the medical officer of health of each district concerned was furnished with particulars. He was asked to keep the preparation of these foods under close observation, to secure that only wholesome materials were used and that these were prepared under proper hygienic conditions. He was also asked to report to the Board any serious default observed, either as regards hygienic considerations or departures from War Office specifications. The classification of these returns and the indispensable correspondence with commanding officers and medical officers of health has thrown a large amount of work on the clerical staff.

Inspectors of foods have systematically visited the works of army food contractors, and have also visited most of the important military districts and conferred with the local medical officer of health.

* * * * * * *

I have the honour to be,
Sir,
Your obedient Servant,

ARTHUR NEWSHOLME.

(7117r—29.) Wt. 48875—554. 875. 1/16. D & S. G 20/22a.

Appendix No. 2.

Report by Dr. A. W. J. MacFadden on the Work of Inspectors of Foods during the Year 1914–15.

Since the outbreak of the war the branch has been deprived of the services of Dr. J. M. Hamill and Dr. G. W. Monier-Williams who are officers in the Territorial Force. Early in 1915 the Board assented to a request by the War Office for loan of the services of two of their Inspectors of Foods to supervise in North America and South America, the carrying out of Army meat contracts. Dr. A. R. Litteljohn has since been carrying out these duties in the former country and Dr. J. Spencer Low in the latter. The reduced staff has been strengthened by the temporary appointment of Dr. H. Hammond Smith and Dr. J. Pearse, the latter of whom has been kindly lent to the Board by the National Health Insurance Commission for England.

War Work.

The ordinary work of the Foods branch during the greater part of the year has been quite overshadowed by that undertaken in connection with the inspection of food for troops.

At the commencement of the war the Board offered the War Office the assistance of their Inspectors of Foods. This offer was accepted and at the desire of the Director of Supplies, I organised a system of special supervision over the preparation of Army food supplies. The Inspectors have since been continuously engaged in maintaining this system. Arrangements were made for the War Office to supply me with particulars as to all Army food contracts, and I arranged with the medical officers of health of the different districts in which work of the kind was being carried out to provide for its special supervision both as regards the wholesomeness and soundness of the materials employed and the sanitary surroundings in which the processes of manufacture were conducted. A most willing response was received from all the medical officers of health concerned, and they and their staffs of inspectors have continued to carry out most valuable work in connection with this supervision. All the food materials of home manufacture which are supplied to our Armies abroad are derived from contractors whose work is controlled in this way.

The arrangement for the supervision of food for the overseas forces has been applied also to the food supplied to troops in this country, but owing to the creation of large new Armies at home expedients for supplementing the ordinary methods of supply had to be devised by the War Office. In many cases caterers were employed by commanding officers to undertake the feeding of the troops under their command at fixed rates. In other instances, where the Army Service Corps supplied the bare rations, tradesmen in the locality, or the canteen contractor, undertook to supply units with the extra food materials for which Army Regulations make provision. It was felt that special supervision of the food supplied to troops from these latter sources was also called for. In view of

the serious pressure which additional work of this kind might cause in the food-preparing premises concerned, the matter was one which was likely to affect not only the food of the soldier but also that of the general public, and arrangements were therefore made to include, so far as was possible, all the food supplied to troops at home in the scheme of special control at the place of preparation which had already been established in the case of the large Army contractors. With this object in view the Director of Supplies made arrangements for me to be supplied by Commanding Officers with details as to the feeding of each unit in the United Kingdom. Information on particular points was also obtained by Medical Inspectors in the course of their visits to the various military camps, and a large number of inquiries were made by the Inspectors of Foods among canteen contractors and others engaged in supplying troops. The information thus obtained has been sifted and dealt with systematically, and information which came to hand as to matters appearing to require attention in Scotland and Ireland has been referred to the Local Government Boards of those countries.

The medical officers of health of the various districts in which it was found that such foods were prepared were asked to undertake the special supervision considered desirable, and to assist in supplying information which would enable the system of inspection to be further extended. They gladly undertook this work, and the zeal with which they and their sanitary inspectors carried out the large amount of additional labour undertaken by them has been gratefully acknowledged by the Army Council.

The measures above referred to have helped to secure high standards of quality and wholesomeness in the materials supplied, and have undoubtedly tended to prevent the recurrence of abuses in connection with the food supply of soldiers such as have been experienced in previous campaigns. I understand that no complaints of a serious nature have been received from the forces abroad as to the quality of the food materials supplied to them.

While the quality of the materials used in the preparation of food for the troops has been found, generally speaking, to be uniformly good, the Inspectors of Foods and the local sanitary officials have had on many occasions to take exception to conditions under which the food was being prepared. Under the existing law sanitary authorities can do but little to control the conditions under which food is prepared for sale for human consumption—their powers being limited, except in those cases where special powers in regard to particular foods have been obtained under local Acts, to securing the abatement of conditions which constitute a nuisance under the Public Health Acts, and to seizing foods which can definitely be said to be unsound, unwholesome or unfit for consumption. The War Office, however, make the requirement in their contracts that the foods supplied for troops shall be prepared under hygienic conditions and to secure due observance of this it has been necessary, in some cases, to insist upon radical alterations in methods ordinarily observed by firms manufacturing the foods. While the conditions found in some of the principal food preparing places concerned were quite satisfactory, many instances have been met with in which manufacturers have not seen or appreciated the necessity of observing ordinary rules of cleanliness in all operations connected with food preparation. It has been quite common to find foods being prepared in rooms littered with dirty rubbish, benches frequently have been dirty and loaded with grease and floors and walls cracked and uneven, thus

harbouring dirt. The state of personal cleanliness of the workers, also, frequently has left much to be desired. Aprons and overalls if worn at all were often filthy, and in some instances old and dirty sacking was considered good enough for the workpeople to wear over their own clothes. Conditions such as these do not ordinarily come within the jurisdiction of sanitary officials, but in the course of their supervision on behalf of the War Department officers of sanitary authorities have been able to secure very marked improvements in these respects. As a rule manufacturers have most willingly carried out the necessary reforms when the need for these has been pointed out. When, however, any reluctance or obstruction has been met with it has usually been sufficient in order to secure compliance to point out that unless the conditions complained of were remedied the matter would be reported to this department with a view to representations being made to the War Office on the subject. In the very few cases in which it has been found necessary to take this extreme step the firm in question has been struck off the list of War Office contractors.

As has already been indicated action in such cases has been possible only through officials being in position to enforce War Office requirements, and it is to be feared that the improved standards of cleanliness which have been secured will not be maintained by many of the firms when they are no longer engaged on War Department work. The information which has been gained by officers engaged on this work emphasises the desirability to which reference was made in last year's report of conferring on sanitary authorities more stringent powers for securing that food for sale for human consumption should be prepared under hygienic conditions.

Our work in connection with the matters referred to above has been greatly facilitated by the unfailing support which I have received from Major-General S. S. Long, C.B., Director of Supplies and Transport, and I gratefully acknowledge my indebtedness for his help.

Miscellaneous Work.

Foods for Infants.

Reference has been made in previous reports to the attention which has been directed in recent years by officers of the Board's medical department to the consideration of questions bearing on the artificial feeding of infants, and several reports have been issued.*

In continuation of this series of inquiries the following reports were published in the year under review :—

I. On the use of Proprietary Foods for Infant Feeding : by Dr. F. J. H. Coutts ; II. On the analysis and composition of some Proprietary Foods for Infants : by Mr. Julian L. Baker, F.I.C. (Food Reports, No. 20.) Report of the Local Government Board upon the effects of certain condensing and drying processes used in the preservation of milk upon its bacterial contents, by Dr. S. Delépine. (Food Reports, No. 21.)

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* Reports on Public Health and Medical subjects. (New Series.)

No. 63. "Boiled Milk as a food for infants and young animals" : by Dr. Janet Lane-Claypon.

No. 76. Biological properties of milk both of the Human species and of cows considered in special relation to the feeding of infants : by Dr. Janet Lane-Claypon.

No. 56. An inquiry as to condensed milks with special reference to their use as Infants' Foods : by Dr. F. J. H. Coutts. (Food Reports, No. 15.)

Mr. Baker's report showed, from analysis of 29 representative samples of proprietary infants' foods, that a large proportion of such foods contained high percentages of starch; that in a great number of cases the starch existed in a practically unchanged condition; that the majority of the foods contained a very low percentage of fats; that the statements in printed matter accompanying the packets of the foods were frequently inaccurate and misleading; and that the exaggerated claims made as to the value of the preparations for infants' foods were not justified.

Dr. Coutts in his report discussed the bearings o the analytical results obtained by Mr. Baker on the suitability of the foods for the diet of infants.

He pointed out that many of the foods even when prepared by mixing with milk and water according to the directions given on the labels, showed a composition differing markedly from that of human milk or of cow's milk. The general question of the suitability of starchy foods for the feeding of infants was discussed and reference was made to the injurious effects of such a diet. Dr. Coutts came to the conclusion that foods containing unchanged starch or starch altered only by heating should not be given to babies under seven months of age except on the advice and under the supervision of a medical man.

The report further dealt with the inaccurate and misleading statements made in labels or advertisements as to proprietary infants' foods, and showed that such statements encouraged the use, by ignorant mothers, of unsuitable foods in the feeding of their infants. Finally the report discussed the possible methods of exercising control over unsuitable infants' foods.

The report by Dr. Delépine records the results of some important experiments on the effect on bacteria of certain processes used in the preservation of milk by condensing and drying. With regard to the tubercle bacillus these experiments indicate that the usual process of preparation of sweetened condensed milk is effective in destroying the virulence of the tubercle bacillus even when the milk condensed originally contained large numbers of this organism in a highly virulent condition. The experiments further show that although certain processes of drying milk fail to destroy the tubercle bacilli entirely, the dried milk being still capable of producing progressive tuberculosis on subcutaneous inoculation into guinea pigs, yet the processes of manufacture, even when a highly tuberculous milk is in question, result in a marked diminution of virulence, the course of the disease produced being very much slower than that of the disease produced in guinea pigs inoculated with untreated tuberculous milk. Young rabbits fed with dried milk containing tubercle bacilli whose virulence had been modified by heating in the course of manufacture, did not contract tuberculosis.

With regard to bacteria generally Dr. Delépine demonstrated that all three methods investigated resulted in a considerable destruction of the bacteria present in the original milk, the reduction being due to the death of *Streptococci*, *Staphylococci*, *Sarcinae*, bacilli of the coli type, *Streptothrichae*, yeasts, &c. The bacteria resisting destruction were mostly sporing bacilli of the types included under the term Bacillus mesentericus.

The experiments showed that there was a stage at which the reduction in the total number of bacteria was much greater than in the finished article, the increase in the final stages being due to re-contamination. By the exercise of proper care this re-contamination

could, to a large extent, be prevented so that the finished article would be superior to that now produced as regards freedom from bacteria

Unsound Food and Foreign Meat Regulations.

In only a few instances has it been found possible for Inspectors of Foods to make the normal inspections at food importing ports in connection with the administration of the Public Health (Foreign Meat) Regulations, 1908 and 1909, and the Public Health (Unsound Food) Regulations, 1908, but reports of medical officers of health show that administration of the Regulations continued to proceed smoothly and satisfactorily.

New "Official Certificates."—In accordance with the provisions of Article I (*h*) of the Foreign Meat Regulations, 1909, the Board have, on receiving the necessary assurances from the governments concerned, notified their acceptance of a label and brand mark as "official certificates" in respect of pork and other edible portions of the pig which have been inspected in Sweden, and of three labels in respect of similar products inspected in three Russian slaughterhouses situated at Koslow, Tambov Government, at Esiporo, South Eastern Railway and at No. 3 Slaughterhouse at Station Nikiforovka of Riasan-Oural Railway, respectively.

Foods in Naval Prizes.—The Admiralty signified their willingness for foodstuffs landed from naval prizes being brought within the purview of the sanitary authorities of the ports concerned. Several visits were made to ports by Inspectors of Foods with a view to securing that such foodstuffs were dealt with in a satisfactory manner.

Milk and Cream Regulations.

The Board have received several representations that hardships have been caused by the administration of the Milk and Cream Regulations, 1912, so far as cream is concerned, and they have had numerous conferences with the trade on the subject. In reply to a question in the House of Commons (21st May, 1914), the President stated that as the evidence available as to the effect upon health of the addition of small quantities of preservatives to cream is to some extent contradictory, he had decided to nominate a small expert Committee to investigate the question afresh. Mr. Samuel also expressed the opinion that pending the completion of this investigation it was inadvisable that local authorities should institute proceedings in respect of boric acid in cream except in cases where the amount of preservative exceeded the amount declared on the label or where the amount so declared was clearly excessive. In consequence of the war and of the absence on military service of several of the proposed members of the suggested Committee and of others concerned, it has not so far been found practicable to proceed with the appointment of the Committee.

Enquiry was made by a public analyst whether "cream" as defined in the Regulations included the article known as "clotted" or "Devonshire" cream. The Board replied that, in their opinion, such cream did come within the definition of "cream" in Article I (*c*) of the Regulations.

Inspection of Food for Export.

The Government of the United States have issued new regulations relating to certificates for meat and meat food products imported into the United States, which came into force on 1st January, 1915. A certificate in Form A is to be given in respect of meat and meat food products derived from animals slaughtered in this country and transported to the United States without unloading in any foreign country, except to transfer the article from one carrier to another. A certificate in Form B is to be given in respect of meat and meat food products the transportation of which to the United States from the country of the slaughter of the animals has been interrupted by unloading in another foreign country for a purpose other than the transfer from one carrier to another. A certificate in Form C is to be given in respect of articles of a kind prepared customarily to be eaten without cooking, which contains muscle tissues of pork.

These certificates supersede those set out in the Board's Memorandum of 1910 on the conditions to be observed in connection with the official certification of meat food products intended for export to the United States of America and the Philippine Islands except so far as the Philippine Islands are concerned. The new regulations at present apply only to the United States, including Alaska, Hawaii and Porto Rico.

Inspectors of Foods have, during the year, paid visits to the premises of many of the firms exporting meat food products to the above-mentioned countries, and have conferred with the certifying officers as to the arrangements made for carrying out the system of certification.

Bacterial Food Poisoning.

During the years under review several outbreaks of food poisoning were brought to the Board's notice. The two most serious of these, that occurring in July in the urban districts of Withnell and Chorley, the other in October and November in the urban districts of Newcastle-under-Lyme and Stoke-on-Trent, had their origins in milk. Dr. Hancock visited these districts and co-operated with the medical officers of health in investigating the outbreaks.

Bacteriological inquiry in connection with both outbreaks was conducted by Professor Delépine of Manchester University. Few outbreaks of food poisoning attributed to milk have been hitherto recorded, and it is noteworthy that these two should have followed so closely on the heels of a similar milk outbreak which occurred in the months of October and November, 1913, at Newcastle-upon-Tyne. As in the case of Newcastle-upon-Tyne outbreak the two now under consideration are of unusual interest from the completeness of the evidence establishing their etiology.

The number of persons affected in the Withnell and Chorley outbreak was 329 and in the Newcastle-under-Lyme outbreak 375; two deaths occurred in each case. In both outbreaks the persons attacked had consumed milk coming from single farms in the rural districts of Chorley and Newcastle-under-Lyme respectively, and in each case the source of infection was traced to a cow which had been ailing for several days antecedent to the outbreak. A food poisoning organism allied to the Bacillus enteritidis of Gaertner was isolated from the organs of the fatal cases available for examination, as well as from material derived from the affected cows.

An outbreak involving 85 persons occurred in May at Cambridge following a dinner which was given in that city. The outbreak is of interest because it is unusual to find fresh salmon associated with illness of this kind. There were present at the dinner 210 persons, and information as to what they had eaten was obtained from all but 14. Of the 196 remaining all but four were found to have eaten salmon. None of these four was affected. Three fish were cooked for the dinner, and all of these were said to have been perfectly normal in appearance, taste and smell at the time of serving, and nothing of an objectionable sort was noted as regards the conditions under which they were prepared. A few fragments of the salmon—all that remained over—were examined by Dr. Graham-Smith, the borough bacteriologist, but no organism such as is commonly associated with outbreaks of food poisoning was discovered. It must not be assumed, however, that all three fish were at fault, and the fact that so many persons who had eaten salmon escaped illness and that a negative bacteriological result was obtained would be explained on the hypothesis that not all of the fish were infected.

Dr. Litteljohn made inquiry into an outbreak of food poisoning which occurred at Oswestry among customers of a pork butcher who had purchased some boiled pressed pork. There were 86 persons affected and one death occurred. Professor Leith of Birmingham University, who conducted the bacteriological inquiry, isolated from the organs of the fatal case as well as from the fæces of two of the sufferers an organism of the enteritidis group. Specimens of blood taken from three of the sufferers gave no definite agglutination reactions. Owing to the fact that information as to the occurrence of the outbreak was delayed none of the original material which was suspected of having caused illness could be obtained.

FOR OFFICIAL USE.

EXTRACT

FROM THE ANNUAL REPORT OF THE

MEDICAL OFFICER

OF

THE LOCAL GOVERNMENT BOARD

For 1916-17.

REPORT ON THE

WORK OF INSPECTORS OF FOODS

For the Year 1916-17.

BEING

A REPORT BY

A. W. J. MACFADDEN, M.B.

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EXTRACT FROM THE REPORT OF THE MEDICAL OFFICER.

TO THE RIGHT HONOURABLE WILLIAM HAYES FISHER, M.P., PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

SIR,

I HAVE the honour to submit the following report concerning the public health of England and Wales during the year 1916, and reviewing, for the year ending March 31st, 1917, the work carried out under the general direction of your medical officer.

* * * * * * * *

WORK OF INSPECTORS OF FOODS.

The work which has been carried out during the year in the Food Inspection Branch of the Medical Department is reported on by Dr. MacFadden, on page 5. The arrangements made at the beginning of the war for supervising the premises and methods of firms engaged in the preparation of food materials for the Army have been continued with success throughout the year. Attention is called to the occurrence during the latter part of 1916 of contamination with arsenic, sometimes in considerable amounts, of materials such as baking powder, egg powder and self-raising flour in which impure acid phosphate of calcium had been used as one of the ingredients. With the co-operation of the local authorities concerned, the occurrence was promptly traced to its sources at the factories where the acid phosphate was manufactured, and steps were taken at once to have the causes of contamination removed. The chief of these appears to have been the utilisation of material known to contain arsenic by mixing it with pure material. As pointed out in the report, this practice is indefensible. The fact that no case of illness was reported in connection with this occurrence is in all probability due to the promptitude with which it was dealt with.

* * * * * * * *

I have the honour to be,

Sir,

Your obedient Servant,

ARTHUR NEWSHOLME.

Appendix No. 2.

Report by Dr. A. W. J. MacFadden on the Work of Inspectors of Foods, during the Year 1916–17.

Food for the Army.—The scheme for the supervision of the preparation of food for the Army referred to in the last two Reports continues to be the main occupation of the Inspectors of Foods. Valuable assistance in this matter is rendered by the Medical Officer of Health and Inspectors of the local authorities concerned, and the general improvement in the conditions of food preparation noted in the previous reports has been maintained and, where necessary, extended. This satisfactory state of things is of course due almost entirely to Inspectors of Foods and Medical Officers of Health being able to enforce the requirements of the Military authorities as to hygienic standards in the production of food for troops. The trade which appears to call for the closest supervision is that of the sausage-maker in a small way of business, and frequent visits to the premises of these are made by Inspectors of local authorities to ensure the maintenance of a satisfactory state of cleanliness. In only a few instances has it been found necessary to take serious exception to the conditions met with.

The supervision of the manufacture of the canned meat imported from South America and the United States and Canada for the use of the Expeditionary Forces has continued to be carried out during the year by Dr. Spencer Low and Dr. Litteljohn, respectively, whose services are on loan to the War Office for that purpose. The former also supervises the preparation of some of the canned meat obtained from South America for the Navy.

Conservation of Wheat.—A considerable amount of attention was paid by the foods branch to the question of what steps could be taken to conserve wheat in the event of a shortage being experienced or threatened, and a number of baking tests were carried out for me with a view of ascertaining whether, and to what extent, other cereal flours and potatoes could be mixed with wheat flour in the making of bread. Towards the end of 1916 the President, on the invitation of the Board of Trade, which Department at the time was responsible for ensuring the food supply of the country, appointed an inter-Departmental Committee, to consider and report what steps could best be taken to increase the yield of flour from wheat, and whether any alteration of the law in regard to mixing other flours with wheat flour was desirable. The Committee comprised, in addition to officials, representative millers and bakers from the United Kingdom, and on their report the Board of Trade issued the Manufacture of Flour and Bread Order, 1917. On the appointment of the Food Controller the Committee's connection with this department ceased.

(13815—29.) Wt. 2756—354. 625. 11/17. D & S. G 20/22a.

Co-operation with other Government Departments.—The branch is in close touch with other Government Departments dealing with questions of food supply, and I have been designated to represent the Board on the Food (War) Committee, appointed by the Royal Society at the request of the Government to advise on matters concerning the food supply of the country.

Arsenic in "Baking Powder Substitute" (Acid Calcium Phosphate).—As a result of action following the outbreak of poisoning in the year 1900 caused by the contamination of beer with arsenic, and of the interest aroused by the Report of the Royal Commission appointed to inquire into this occurrence, the people of this country have experienced for many years past a very satisfactory degree of immunity from contamination of articles of food and drink with arsenic. It is therefore of importance that any departure from these conditions should be investigated and recorded.

In a letter dated September 23rd, 1916, Sir James Dobbie informed me that a sample of phosphate baking powder which had been sent with a tender for War Office supplies had been found at the Government Laboratory to contain 32 parts of arsenic per million. Inquiries were made at once by Dr. Hammond Smith into the origin of this sample. It was found that the firm tendering the sample to the War Office were merely mixers of the various ingredients which enter into the composition of such baking powders. In this instance the ingredients consisted of cream of tartar substitute (acid calcium phosphate), sodium bicarbonate and ground rice. Examination of these materials proved, as was to be expected, that all the arsenic was contained in the acid calcium phosphate used. This had been obtained by the baking powder manufacturer from a firm of dealers in the City who in turn had been supplied by a firm of chemical manufacturers in Scotland. As soon as they were informed of the facts both the baking powder manufacturer and the dealer who supplied him with the acid calcium phosphate took steps to recall from sale all the materials implicated which had been issued by them. The Scottish Local Government Board was informed of the facts with a view to having the matter brought to the notice of the Scottish chemical manufacturer concerned.

The results of these preliminary inquiries suggested the immediate importance of ascertaining whether impure acid phosphate from other sources was being used in the preparation of food-materials, and it was arranged that I should send a circular letter to the Medical Officer of Health or other administrative officer of each of the Sale of Food and Drugs Acts Authorities, informing him of what had been found. A circular letter dated the 16th October, 1916, was accordingly sent in which I pointed out the desirability of having special samples taken for examination by the Public Analyst of each district of such articles as baking powder, egg powder, self raising flour, cream of tarter substitute and other similar materials likely to contain acid calcium phosphate. At the same time I asked to be furnished with particulars of any samples in which arsenic was found.

The replies to this letter which I received in the course of the next few weeks showed that in a large number of districts arsenic had been found in the samples examined. In the majority of cases however the amounts reported were relatively small and as judged by the limit laid down by the Royal Commission on Arsenical Poisoning, viz., $\frac{1}{100}$ of a grain of arsenic per pound (1·43 parts per million), did not call for special action. In some 50 cases the amounts reported were clearly excessive, reaching as much as 400

parts of arsenic per million. One sample of "cream of tartar substitute" *i.e.* unmixed acid calcium phosphate, contained no less than $4\frac{1}{2}$ grains of arsenic per lb. (or 643 parts per million). By arrangement with the local officer concerned the history and origin of the contaminated materials were traced in most cases to the actual maker of the acid phosphate and thanks to the promptitude with which this was accomplished I was early in position to have each of the half dozen chemical works concerned visited by an Inspector of Foods armed with definite evidence of the fact that contaminated material had been issued from the factory. All the firms had already become aware of the situation through the activity of the Sale of Food and Drugs Acts authorities and many of them had in their possession stocks of contaminated acid phosphate which had been returned to them by manufacturers and vendors of baking powders which had been reported against.

It was not difficult to discover the causes of the occurrence at the various chemical works. For the most part they were primarily due to serious disarrangements connected with the supply of raw material and reductions of staff caused by the war. Owing to the great demand for sulphuric acid by munition manufacturers, supplies of this material, which is essential to the preparation of acid phosphates, were difficult to obtain and were often highly contaminated with arsenic. Most of the acid phosphate makers who had previously been accustomed to draw their supplies of sulphuric acid from sources of guaranteed purity were unprepared for dealing adequately with impure material. Purifying plants had been set up by some of these manufacturers but inexperience in their use had prevented uniformly satisfactory results from being attained. Some of those who customarily employed purifying plants failed to use them adequately. In one or two cases no attempt at all had been made to purify the material from arsenic. For the most part acid phosphate manufacturers had been well aware of the unsatisfactory nature of the products they were preparing but none of them appeared to realise the existence of so high a degree of impurity as our examinations revealed in many cases. Arrangements for the chemical analysis of their products had been made by most of the firms concerned either by their own analytical staffs or by outside analysts. In most cases those arrangements had suffered by the war, but even where they had been fairly well maintained the information supplied was not properly used. For example, it was found to be a common practice of manufacturers to dispose of acid phosphate which had turned out on their own analysis to be considerably contaminated, by mixing it with another lot of the product which was free from, or only slightly contaminated with arsenic. It is easy to see how this dangerous and reprehensible practice might account for all the cases of contamination, great and small, revealed by the analyses of public analysts. Whatever extenuating circumstances, such as war-time conditions, might be pleaded for failing to secure a high standard of purity in all the acid phosphate manufactured, nothing can excuse the deliberate addition to an article intended for food purposes of a material known to be contaminated with a dangerous poison.

At each of the factories visited an undertaking was given by the firm that this practice of mixing contaminated with relatively pure material would be discontinued at once, and that no acid phosphate which had not been analysed and found to conform with the

generally recognised standards of purity as regards arsenic would be issued from the factory. Towards the end of our enquiry the manufacturers of acid phosphates met in London to discuss the best methods by which they might overcome the technical difficulties with which they had to deal. There was a disposition amongst some of them to regard the Royal Commission standard as being unnecessarily severe having regard to war conditions. My opinion was asked on this point, and I made it clear that in my view there could be no question of relaxing the standard of purity as regards arsenic in articles intended for human consumption which was laid down by the Royal Commission. This view was accepted, and judging from subsequent enquiries and analytical reports it appears to have been complied with in practice.

It is of interest to note here that samples of imported acid calcium phosphate taken during this inquiry were found by the Government Chemist to be free from arsenic.

The action taken by local authorities where samples containing excessive quantities of arsenic were reported was in most instances to obtain from the vendor, generally a grocer or other small retailer, surrender for destruction of the remainder of his stock of this particular material. Steps were also taken to insure that the maker of the particular baking powder or egg powder in question recalled from his other retail customers similar stocks which were likely to be contaminated. He in turn threw back on the hands of the merchant who had supplied him what remained in his possession of the contaminated stock of acid phosphate, and this in due course was returned to the works of the original manufacturer, and was dealt with in a suitable manner. In some instances legal proceedings were taken against retailers by the local authority, and fines were inflicted.

Their experiences in connection with this occurrence will no doubt have convinced dealers in acid phosphate, makers of baking powders and other materials into which it enters, and also the retailers of such articles of the paramount necessity for obtaining a guarantee as to the purity and wholesomeness of the material. It is obviously the duty of merchants dealing with such substances, and of the makers of baking powders and other similar articles to check by means of analysis the accuracy of any guarantees obtained from manufacturers. Our inquiries have indicated that this duty was not sufficiently observed by the traders concerned.

Milk and Cream Regulations.—Since the Regulations of 1912 were issued numerous representations have been made to the Board on the subject of boric acid in cream. Some of these have urged that the use of preservatives in cream should be wholly prohibited, others that it would be impracticable to carry on the present trade in jugged cream unless some small amount of preservative were added, and the Department has been asked to lay down a maximum limit. The question is one of some difficulty, and it was decided to appoint a small expert Committee for the purpose of enquiring further in regard to it. In consequence of the War, the appointment of this Committee has necessarily been postponed, and as an interim measure, the Board issued the Public Health (Milk and Cream) Regulations, 1912, Amendment Order, 1917. These Regulations require that preserved cream shall not contain more than 0·4 per cent. of boric acid and that the declaratory label required by the Regulations of 1912 to be affixed to every receptacle containing

preserved cream shall bear on it the words "not suitable for infants and invalids." The Regulations also permit that in the case of receptacles made of cardboard the declaratory label may be printed on the outside of the cardboard itself instead of being in the form of an adhesive label as prescribed by the earlier Regulations.

In issuing the amending Regulations the Board had no intention of deciding the question whether boric acid in preserved cream to an amount not exceeding 0·4 per cent. renders the article injurious to the health of the ordinary consumer.